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(See page 277)

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The Maintenance of Scientific Proficiency in Nonacademic Research Laboratories

Leonard B. Loeb

University of California, Berkeley

DURING AND IN CONSEQUENCE OF THE UPHEAVALS incident to World War II the technical research laboratories of this country, both civil service and industrial, have been restaffed and reorganized on distinctly high levels of proficiency. It is essential for the national welfare that they be maintained at the present level or improved. On the other hand, past experience indicates that, unless something is done, this efficiency will gradually decline. In fact, closer scrutiny indicates that the relaxation characteristic of such reversion is already setting in and that after 4:30 P.M. the professional aspects of life are giving way to recreational interests.

The questions before us are: Why does this happen? What can be done about it? Basically, the problem is a human one. Man is naturally lazy and will exert himself to an effort compatible with his personal limitations only in so far as his (a) need for self-expression in creative effort (including in this true scientific curiosity), (b) desire for prestige and/or power, (c) desire for economic advancement, or (d) fear of losing his livelihood requires. In that section of the academic world offering research facilities, circumstances foster the three more positive (a, b, and c) of these four incentives. This stems from the fact that salaries are paid primarily for teaching. Thus, the academic man is left very free in his choice of research subjects (a), making his creative effort entirely his own and hence giving the creative instinct its full fruition. Again, promotion (b and c) in the academic research field is definitely more strongly based on scholarship and research achievement than is the case in civil service and industry, where administrative capacity plays an important role. In addition, there is in the academic research career the stimulus and the broadening influence of teaching. Such a broadening element is completely lacking in the present organization of research laboratories. Finally, there is the sabbatical year in which the academic man is expected to go elsewhere for study to broaden his experience and extend his knowledge.

In the civil service and industrial research laboratories the situation is somewhat different. The character of the tasks assigned limits the latitude

for autonomy in choice of subject or approach. In a considerable measure, and certainly in the lower brackets, the type of problems requires team work and cooperative effort. These factors, together with the occasional restrictions on publication and the frequent joint publication, do much to nullify the individual creative-effort motive. While advancement in industry could be largely on the basis of achievement, the larger organizations make much discrimination inadvisable, and cooperative effort makes the recognition of an individual contribution difficult. Doubtless glaring exceptions to these generalizations occur, but in the main they apply. In the civil service field the restrictions on promotion, particularly with regard to administrative responsibility, place very severe limitations on the proper utilization of the advancement motive in creative or research achievement. Again, in both types of organization the larger staffs and problems of efficiency in employment tend to narrow down the scope of a worker's activities, and there are neither courses nor students to broaden or advance his knowledge. Furthermore, in both these services the needs for a considerable number of high-grade technicians as the "hewers of wood and drawers of water," together with civil service regulations, make the elimination of the unambitious but limitedly useful employee nearly impossible. Thus, even the fear motive of losing one's livelihood is lacking in some measure. In consequence, the more enterprising, ambitious, and capable receive enticing offers and leave, and the less ambitious remain, growing yearly narrower in their professional interests, duller and more inflexible in their work.

In my various assignments and experience as well as in many conversations with my colleagues who now direct such enterprises I have given much thought to this question and have arrived at some conclusions leading to *positive* recommendations for improvement. I am certain that many of the remedies suggested cannot be applied at once—perhaps not for years—but that some of these remedies, perhaps in modified form, can be initiated *now*. I also believe that something along these lines must be done in the near future; otherwise, industry and civil service will again find themselves cluttered up with dead lumber, with

no room for the very capable young workers to be turned out by the universities in the next 10 years. It is therefore at the risk of stirring up controversy and adverse criticism that the following is written toward, it is hoped, a worthy objective.

It is my opinion, based on years of close observation, that, irrespective of popular belief, the one *large government agency* which at the beginning of the war had shown itself to have been at an exceptionally high degree of *professional* efficiency in its specialized field of activity was the United States Navy. In making this statement I want it clearly understood that I am not referring to the Navy's proficiency in research, but in its professed objective—that of being a competent, offensive, sea-going Navy. Few people realize how easy it could have been for the Navy to have failed badly in the prewar years through even the slightest inertia with the existing lack of proper support and interest. The not inconsiderable success in maintaining efficiency was achieved by a number of largely self-imposed measures devised for that purpose and, in considerable measure, unique to the Navy. These may be listed as follows:

(1) Careful initial selection of officer personnel based on competitive examinations.

(2) Intensive and selective training.

(3) Relatively frequent fitness reports by varied senior officers, which over the years form a most comprehensive record.

(4) Appropriate commendations and citations for meritorious performance even in peacetime.

(5) Change of duties, and transfer of station every two to three years.

(6) Selection for promotion by a critical board of reviewers in competition with a considerable number of their contemporaries. (This selection was very careful and thorough. Those failing selection were retired at the end of some few years for "age in grade" at an appropriate pension.)

(7) An extensive system of written examinations for promotions appropriate to each grade.

(8) Encouragement to growth by utilizing spare time in additional fields of study by means of specialized correspondence courses.

(9) At the end of 7-year periods the selection of officers scheduled for advancement to at least a year of sabbatical study at the Naval Post Graduate School, the War College, or at the various universities.

(10) Relatively early retirement at a living wage.

(11) Maintenance of a balanced dynamic organization of pyramidal structure by means of items 6 and 10 above.

It must be noted that the tasks imposed in some of the items above had to be done out of hours on the standard 8-hour day, 5½-day week of normal operating duties. It is possible that such pressure may have

acted adversely on the health and longevity of the personnel involved and perhaps should not have been pushed too far. Nevertheless, whether one approves of the product or not, one must admit that with such a system adequately carried out there is ample pressure to keep the officers alive mentally, to broaden the scope of their knowledge by changing duties and adequate schooling, carefully to select the abler officer for promotion on the basis of adequate and varied data, and finally, to stimulate additional scholastic achievement in correspondence courses with appropriate citations on their records.

Since professional scientific personnel are economically and educationally in the same level of the social structure as naval officers, it is therefore logical to inquire whether some of these apparently successful measures can perhaps be carried over in modified form to the nonacademic research laboratories. As will be seen below, I am certain that, despite probable determined opposition by the inferior and doctrinaire elements in such laboratories, the principles can in considerable measure be adopted to serve a useful purpose. These various measures will be considered in order.

(1) and (2): Unlike Navy personnel, scientists hired by industry and civil service should have completed their training before being hired. I am convinced that "in-service" training for *degrees* requiring academic credit, is educationally generally unsatisfactory and unsound. This statement will arouse a strenuous protest in certain quarters and on this account needs elucidation in order that the thesis of this article may be maintained. In consequence of the short-sighted draft policy with respect to scientific education during the late war, together with the urgent wartime personnel requirements, a most unhealthy and unusual situation has arisen. Large numbers of half-trained young scientists were employed in laboratories and became useful technical operators. Many of them married and have children. These men are of course not eligible for the educational opportunities provided by Congress under legislation for veterans of the armed forces. Many of them are very able. Their future is hampered by virtue of their incomplete or inadequate education. They have in large measure remained in the research laboratories, in which they are valuable. In order to improve their personnel and retain the services of these men, some of the larger and fortunately situated research laboratories, in collaboration with neighboring collegiate and university-grade institutions, have evolved a most amazing system of "in-service" education. In order to give residence and certify degree credit, these academic institutions have placed on their faculty some capable and some less capable full-time members

of the staffs of the research laboratories in question. In this fashion the research laboratory becomes a part of the campus of the academic institution. Credit courses leading to the bachelor's and doctor's degree are then given for the most part out of hours at the research laboratory, largely by its own staff and partly by regular academic faculty. The doctoral dissertation is done at the research laboratory under partial supervision by the university faculty but associated with the man's paid research activity. It appears that under this very convenient scheme students have achieved the baccalaureate and doctoral degrees in not many more years than are required in full-time study in academic institutions. Doubtless some of these men have advanced and matured through their wartime research activities. Nonetheless, in the face of such rapid achievement of the degree, one may properly ask whether the normal academic procedures of the past are too exacting for these degrees or whether the degrees so quickly achieved have much significance. Presently, however, there is an acute shortage of trained men on the higher educational level, and we owe the men caught by the war some chance to advance. Thus, I can only admire the aggressiveness and ingenuity of the educational program personnel of those laboratories for their success in achieving what *must* only be the *temporary emergency solution* of a difficult problem.

For the future of American science and the national safety the education of our scientific personnel must be on a high and sound level. This cannot properly be achieved on a long-drawn-out, part-time, night school type of program. The National Science Foundation when it is established must provide means for full-time, concentrated, coordinated study periods for our ablest young men in institutions designed for that purpose and where work is conducted by men sufficiently engaged in the practice of instruction and study to carry it out properly. In the research institutions, aside from the piecemeal character of the instruction on a temporal basis, neither the occupational environment, the necessity of effectively earning one's living, nor the character of the casual lecturer whose full time in theory is given to research can contribute to sound scholarship. Thus, it must be asserted that academic credit and degree training is *not* the proper or normal function of a research laboratory and, further, that such laboratories must, unlike the Navy with its specialized vocational education, accept only the best available of the adequately trained personnel at the levels required. If some of their exceptionally able men, taken in at a lower educational level, wish to receive further academic training after the present emergency is over, they should be sent on sabbatical leave with pay or on a

Science Foundation scholarship to an appropriate academic institution to complete their training.¹

It should furthermore be made clear to the employee on hiring that, with the particular education which he has, he can normally expect no promotion beyond a certain grade. Rare exceptions in promotion of remarkable but inadequately trained men could be made but then primarily in an administrative capacity with certain exceptions to be noted. The men who by education are not eligible for promotion beyond a certain grade should if they wish, be retained in their proper and useful function or encouraged to seek other employment. If they choose to stay on, they should not by measures indicated below be permitted to narrow down. Such narrowing down will naturally vary greatly with the nature of the unit to which they are assigned.

(3) and (4): Some attempt is made in civil service to get at a continuous performance record by means of the very stultified efficiency rating system. It has many weaknesses aside from that of being set in terms of a form which is incapable of applications to the wide variations of human character and the diversity of qualifications required for any given scientific task. The form suffers also from the general permanence of an employee's departmental assignment, so that the variation in reporting seniors is not great. Furthermore, the most valuable evaluation of an individual is through the immediate supervisor's estimate of the man's characteristics and achievement as expressed in a carefully worded description, provision for which is usually not mandatory in such ratings but is mandatory in the fitness report of the Navy. It is further desirable to have data on a man's intellectual growth in the form of objective grading on the basis of performance as manifested by written examinations. An additional positive set of data on the man is possible in terms of annual commendation awards, as is the current naval practice. Thus, where a project has been expeditiously done, a clever design is proposed and executed, or a notable advance in knowledge is made, the department head, through his chain of command, can ascertain with a fair degree of accuracy the contributions of each of the men. With this information at hand it is then possible to award an appropriately worded distinguished, meritorious, or commendatory citation to be placed in the man's record. This was done near the end of the war in two civilian naval units with which I was connected with definitely beneficial results with respect

¹ In occasional cases it is permissible, and perhaps useful, for the student to complete his doctoral *research dissertation* at his own research laboratory on a subject acceptable to his university, under joint supervision, once he has *otherwise qualified* for the degree.

to both record and morale. Unfortunately, this practice was later considered to be too much of a bother and was discontinued. However, the achievement of good morale and efficiency is always a bother. At any rate, this would add a separate factor which would cumulatively give valuable support where meritorious selection for promotion is considered. These measures could be utilized for increasing the scope and value of the fitness report data.

(5): Probably the most effective item in keeping laboratory personnel broadened and alive is change of work assignments requiring the acquisition of new knowledge and techniques in greater or less degree. For example, I believe that a good physicist, if properly trained, is an all-around physicist, not just a nuclear, an electronic, or an optical specialist. He should without too much effort be capable of useful employment in, for example, electronics, optics, or acoustics, irrespective of the subject on which he did his Ph.D. thesis. If he cannot do this, he is not a physicist. The same should apply to engineers. It is therefore imperative in a man's first 10-15 years of service that he change fields of activity at least three times. Through exigencies of teaching, the average academic man has in a like period covered numerous and diversified fields of study. Considerably more specializations should perhaps be allowed the more senior research personnel, but here at least they should, by virtue of their positions and by earlier training, be broader than the younger men. With curtailed staffs as at present, it may not be convenient or even most efficient to rotate the personnel on the P-1 to P-3 civil service levels in their fields of activity. Nevertheless, it *must* be done in the interest of their and the laboratories' future, for with inadequate background education plus intensive specializations without the stimulus of learning a new job, laziness, narrowness, and inertia will conquer. The result is that the organizations will have many useless narrow specialists on their hands whom they cannot use when the interest focuses on other fields and whom no one else will hire. Rotation will also insure a wider diversity of fitness reports. Rotation in duty in the Navy is a requisite for higher command as well as for maintenance of efficiency. In research laboratories it is imperative for the latter purpose only.

(6): Selection for promotion in some universities and probably in some measure in industry and less in civil service is done on the basis of impartial selection boards or promotion committees. It is believed that, because of the lack of uniformity in the duties and backgrounds of individuals even in a given grade in research laboratories, it is impossible to promote on the wholesale comparative basis as in the Navy. It is, however, desirable for the sake of uniformity that

while promotion is recommended by a given divisional group for its personnel, the selection boards have on them representatives of other divisions. This will mediate against injustices and favoritism. I was shocked to discover how little this practice is now used in certain otherwise excellent research laboratories. The disposal of those failing selection must be diverse. They should be encouraged to seek employment more suited to their talents elsewhere and helped to obtain such employment. Otherwise, they may be retained in the status quo as high-grade technicians, but their duties should continue to be varied at least in three yearly intervals until they find their stride. They also should be made to continue study. This problem is a serious one which will later be discussed in another connection.

(7): The promotion examination which was eliminated in the Navy during the war is now being reinstituted. While it has its merits, it is probably not possible or desirable to enforce such a system in research laboratories. It is, of course, entirely feasible to institute a set of advanced written examinations for those very able men who by virtue of past education do not qualify for a higher grade but whose abilities mark them as desirable for promotion. Preparation for such examinations can be had by the educational systems suggested below. Thus, on the basis of passing certain advanced examinations of broader scope, the selected few could achieve promotion without a higher degree. At least consideration could be given to such a scheme.

(8): It is now essential to consider the question of "in-service" training as epitomized by the naval correspondence courses. Such training is *not*, however, *to be confused with collegiate credit courses at any level*, as elsewhere stated. "Lifelong learning" is an absolute imperative in nonacademic research laboratories if efficiency is to be maintained and stagnation avoided. Toward this end the following scheme is proposed: (a) The year is to be divided into four quarters. (b) All members of the staff must engage in some sort of controlled and coordinated study programs or their equivalent for three out of the four quarters. (c) Of the three quarters of study, two of them are to be devoted to the study of some subject or field not immediately connected with the main field of research interest of that individual. One quarter may be devoted to a study appropriate to that field. (d) The courses of instruction should be divided into at least two and perhaps more levels—graduate study levels for those with the bachelor's degree, no collegiate credit; seminar level for those with the doctor's degree. (e) The first category should consist of courses such as mathematics and mathematical physics, atomic structure,

nuclear physics, advanced heat and kinetic theory, electrical theory, electronics, gaseous electronics, hydrodynamics, advanced mechanics, acoustics, optics, etc., just to mention a few as examples. (f) Instructors for these courses could be drawn from the senior staff members with adequate qualifications or from outside and hired on a contract basis. (g) All such courses should meet *no more* than 3 hours a week and require at least 6-9 hours of outside homework weekly, with problems and a final written examination. (h) Men with a doctor's degree would have group seminars of no more than 15-20 members meeting twice a week for 2 hours each. These should be assigned fields of study requiring the reading of current advanced monographs and articles in scientific periodicals. Each member should be required to work up an original paper to be presented over a 2-hour session and submit it in writing with adequate references. The choice of assignments should be based on some new advanced field of study, e.g. the solid state, electron theory of metals, nuclear physics, atomic physics, microwave analysis, radar techniques, etc. Each participant would be graded by the three senior members of the group. (i) Those more senior staff members presenting courses for the lower groups should be allowed to substitute such instruction in lieu of a seminar, provided that they teach a sufficient spread of courses to broaden their outlook. (j) All grades should be filed in the confidential file of the person involved and would be seen only by the grading authority and those with access to the files. To prevent gossip and ill feeling, the grade would not be divulged to the students at any time. Such grades should assist in evaluating the individual's intellectual growth. It should be noted in passing that, while no collegiate degree credit is given, such a study system will greatly facilitate the advancement to candidacy for higher degrees for those taking leave to obtain a doctoral degree. It is also to be noted that this type of training should be applied to *all* scientific or research personnel on a professional level. It requires some evenings of home study instead of indulging in hobbies when 4:30 comes around and is aimed at broadening *all* individuals and keeping them up to date. It forces those who would otherwise relax and encourages and directs those who wish to grow.

(9): The sabbatical leave year of refresher and advanced study for qualified research personnel after some 7 years of duty is possible of achievement. Under civil service it probably cannot as yet be achieved, although bills toward this end are being placed before Congress. It *must* be striven for. The naval precedent for such study could be used with telling effect. Agreements for continued service in

the laboratory after such study could be provided as with the Navy. Some help could *now* be achieved by exchange of suitable personnel with universities and industry. This would have an all-around beneficial effect for the future national welfare. It is believed that while no serious attempt at such exchanges have been made in the past, they can be essayed on a person-for-person basis in a number of appropriate cases. It is to be concluded that the equivalent of a sabbatical year for appropriate study by able personnel should be striven for either on an exchange or on a direct basis.

(10): The question of retirement at an earlier age on a living wage is important in order to make possible a more dynamic flow in the top positions. It should be subject to considerable flexibility in individual cases. It would not preclude useful activity for retired personnel, as witness the diversity of useful employment for able retired naval officers.

(11): Of necessity, the Navy must maintain an organization in which the number of officers in the different ranks decreases with rank, giving the organization a pyramidal structure of population in rank. In academic institutions such a structure is not as imperative if the senior professorial ranks are willing to share alike in the burden of lower-grade instruction. Faculty groups are small, and administrative function is limited. Sound academic institutions will, however, fill their ranks from below with proper junior personnel and promote in the measure of a man's research and creative achievement. In the larger research laboratories the size, the cooperative nature of most projects, the character of much of the work, and the considerable administrative function required, especially by civil service, introduce situations akin to those met with in the Navy although to a lesser degree. Still a large number of lower-grade, technically competent professional operatives are employed. This, together with the directive and supervisory functions needed in large organizations, makes a pyramidal type of organization imperative. On the other hand, it is urgent that personnel be attracted to and retained in such laboratories. This implies a sense of security and opportunity for advancement. The Navy maintains its pyramidal structure by feeding in at the lowest rank of its officer personnel and through its accentuated system of fitness reports, promotion examinations, and selection boards, retiring personnel as this becomes necessary while promoting the able ones. It maintains its morale by retiring those officers who fail to make the grade and by a sensible and fair retirement and pension system. Thus, officers retired on failure to achieve promotion are assured of retirement after a certain number of years in service under such conditions that, with their

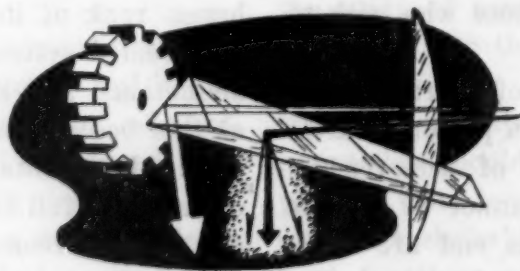
pension, they can be certain of a livelihood while readjusting to rehabilitation in civil life.²

The situation in research laboratories, especially under civil service, in contrast to the Navy, is at the present writing alarming in a high degree. Manpower in such organizations, even with urgent needs and extensive programs, is limited by what are known as ceilings. These are limitations imposed by Congressional action on the total number of personnel aboard including the very necessary nonprofessional service personnel, irrespective of rank or function. They limit hiring on sound functional and program bases. During the war hiring was extensive, and in general such hiring yielded a healthy pyramidal structure, though with a shortage of senior personnel. Thus, during the war rapid promotion was urgent and was effected. With the advent of peace and the placing of relatively low manpower ceilings a peculiar structural change took place. Junior ratings were dropped, and the abler and more experienced employees were retained at higher ratings. In addition, with the urgent need for retaining the services of competent personnel, in a labor market depleted in lower ratings by the draft, promotion was utilized as an incentive for holding valuable personnel. This was aggravated by competition with academic institutions and industrial laboratories offering better financial inducements. In consequence, in the civil service research laboratories the following trend is universal. In 1945 the peak of the employment curve lay between the P-1 and P-2 levels with a proper decline in the higher ratings. In 1948 the peak lies

²It appears that with the consolidation of the armed forces under the Secretary of Defense a new system of contributory retiring annuities is being proposed to replace the excellent pension system now in force in the Navy. Judging from the lamentable conditions faced by academic staffs under such a system in these inflationary years, the Secretariat of Defense is ruining an otherwise very effective and human system. This will seriously impair the efficiency of the present Navy and will discourage enrollment and retirement of the present high grade of personnel. It is hoped that serious consideration will be given to this change before it is too late.

between the P-3 and P-4 ratings with ceilings filled and relatively few P-1 ratings present. The significance of this situation is, first, that work normally done by those with P-1 ratings is now being done by men with a P-3 rating. Secondly, it signifies that in the next years promotion of only a very few of these men will be possible. This will cause serious discontent among the present personnel with the abler personnel leaving and the less able remaining. Thirdly, it signifies that when the production of capable technical personnel from the intensive academic mass-training programs now in force reaches the labor market, there will be no places available for a healthy filling of quotas from below. As far as I can see, the *only* proper solution lies in the speedy enactment of legislation permitting a retirement on pension or subsidy, based on length of service, which will make it possible to retire overcomplement higher ratings without loss of morale and permit replenishment from below. Pensions on such a system need not be payable for life as with the Navy. They should be of such character that for three to four years the personnel have a salary sufficient to permit them to go to universities or otherwise prepare for employment that will insure their future. They, like the GIs, are also in a measure war casualties. Such a scheme is not without precedent in the academic world for nontenure appointees (below the rank of associate professor). If after 5-7 years of service, with an education on the higher level complete, a faculty member cannot expect to receive promotion, he is given a year on full pay to seek other employment. The writer therefore urges that aggressive action at once be taken toward establishing some sort of a retirement for "age in grade" plan and, with it, proceeding by means of the proper selection boards to re-establish the balance of a healthy organizational structure.

It is believed that if this general plan as outlined above, and with modifications appropriate to the particular laboratory, can be put into operation, there is a hope that stagnation and deterioration of scientific proficiency can in a large measure be avoided.



American Association for the Advancement of Science

The Centennial Celebration—Washington, D. C.

September 13-17, 1948

Westinghouse Science Writing Awards

Two \$1,000 prize awards for excellence in science writing in newspapers and general-circulation magazines will be presented on September 16 to Frank Carey, science writer in the Washington, D. C., Bureau of Associated Press, and to Florence Moog, free-lance writer and assistant professor of zoology at Washington University, St. Louis.

Judged best among 78 newspaper entries, Mr. Carey's four-part article dealt with chloromycetin, the new antibiotic which has shown promise in combatting several of the rickettsial diseases, parrot fever, and one of the venereal diseases. The story told of the first isolation of the actinomycete producing the antibiotic from a sample of soil from Caracas, Venezuela, early experimental work with the product, and more recent work using it against epidemic typhus in South America and Mexico and against scrub typhus in Kuala Lumpur, Malaya. Mr. Carey has been a newspaperman since 1931, becoming a full-time science writer in 1943. In 1946 he received a Nieman fellowship from Harvard University.

From 102 magazine entries, the judges selected an article from the June 1948 issue of the *Scientific American*, entitled "The Biology of Old Age." In this Dr. Moog discusses physiological aspects of aging in living tissues and possibilities for increasing the effective span of human life. Dr. Moog has contributed articles to several newspapers and magazines and is at present engaged in research on biochemical embryology at Washington University.

Honorable mention will be given Herbert Yahraes for his article, "Static From the Stars," which appeared in the January 1948 issue of *Popular Science Monthly*. The story is devoted to the work of Grote Reber, especially that now in progress with the National Bureau of Standards, in which radiations from outer space are being recorded by a radio telescope. Mr. Yahraes has been editor of *PM*, but now is a free-lance writer on scientific and medical subjects.

The 1948 judges included H. L. Mencken, Clifton Fadiman, Rudolf Flesch, Edward Weeks, H. R. Aldrich, Detlev Bronk, John R. Dunning, and Morris Meister (chairman).

Presentation ceremonies honoring the winners and the publications which they represent will be held September 16 at the Statler Hotel in Washington, D. C.

Broadcasting the Centenary

Those unable to attend the Centennial Celebration of the Association this coming week may wish to follow radio reports of the meeting. Daily from Monday through Friday at 6:15 P.M., Daylight Saving Time (DST), Quincy Howe, of the CBS network, will bring to the listening audience excerpts and full reports of interviews with attending scientists and summaries of representative papers in his program, "Frontiers of Science."

Also to be heard over CBS is "Adventures in Science," moderated by Watson Davis, director of Science Service, which will be devoted to previews and postviews of the meeting at 3:15 P.M., DST, Saturday, September 11, and Saturday, September 18. Participants in the preview broadcast for September 11 include Ralph Cleland, chairman of the American Institutes of Biological Sciences, and Raymund L. Zwemer, executive secretary of the National Academy of Sciences.

On Tuesday evening, September 14, at 8:30 P.M., DST, America's Town Meeting of the Air will be presented under the auspices of the Association through the usual ABC outlets. The participants include Fairfield Osborn, president of the New York Zoological Society; Brock Chisholm, director, World Health Organization; Harlow Shapley, director of the Harvard College Observatory; and Edmund W. Sinnott, president of the AAAS and director of the Sheffield Scientific School, Yale University. The subject of the Town Meeting forum will be "What Hope for Man?"

Other programs have been tentatively scheduled by the NBC and Mutual networks, as have a number of local and regional broadcasts, such as the Georgetown University Forum of the Air. The World Wide Broadcasting Foundation will beam recorded broadcasts of the Centennial meeting to foreign countries, including English and translated versions. Portions of many of the lectures and symposium discussions will be recorded by the Foundation for distribution to university radio stations and other local outlets.

The George Washington University

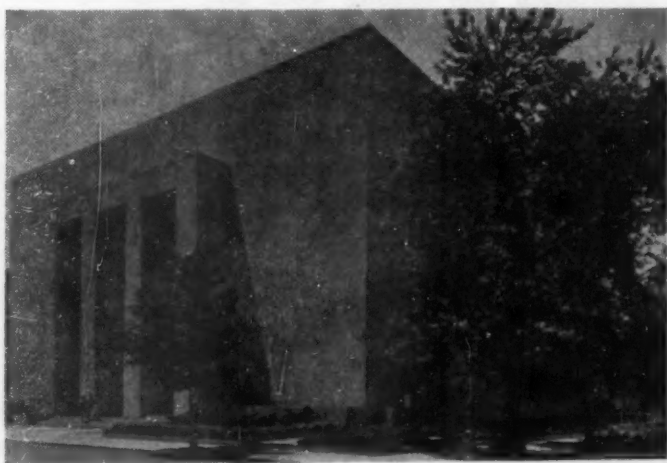
Four blocks west of the White House in the Nation's capital are situated the 45 buildings which comprise the campus of The George Washington University.

This nonsectarian institution of higher learning for men and women was founded in 1821. Its name com-

memorates the Father of Our Country, who urged its establishment and willed funds for that purpose. Although it is not under governmental control, it serves as a great national university. Its 19,500 alumni live in every state in the Union and in most foreign countries.

The University is composed of the Junior College; Columbian College, the senior college of arts and sciences; the Graduate Council; the School of Medicine; the Law School; the School of Engineering; the School of Pharmacy; the School of Education; the School of Government; the Division of University Students; the Division of Special Students; and the Summer Sessions.

Its educational policy is concerned with the democratic principle of educating individuals for all levels of leadership. A liberal arts groundwork is a prerequisite for specialized programs in all its schools.



Lisner Auditorium, used for University classes and functions and also for meetings of cultural and scientific groups. (Photo by Blakesless-Lane, Washington, D. C.)

The University seeks to use fully the opportunities afforded by its location at the seat of the National Government. At its very doors are departments of the U. S. Government, great national libraries, museums and arts collections, headquarters of national and international scientific, educational, and economic organizations. Within a slightly longer radius are the halls of the U. S. Congress, the Supreme Court, the Library of Congress, the embassies and legations of foreign nations, and bureaus, experimental stations, laboratories, and observatories that serve every science.

As these groups make consultants and source materials available to the University, the University provides them with trained specialists as employees and devotes attention in classroom and laboratory to their special problems. The University's research program is largely concerned with projects for governmental and private health and scientific agencies in Washington, D. C. Two years ago the University created the position of coordinator of scientific activities as an associate position to that of the director of its Graduate Council.

The University's new teaching hospital, which also functions as a research center, is a strategically located center where physicians of the Federal Government and the city can consult.

The George Washington University is proud that the

first announcement in America of the fission of uranium with the release of atomic energy was made in one of its classrooms. University President Cloyd H. Marvin brought experts in this field to the University during the early 1930s and urged development of the Washington Conference on Theoretical Physics. It was at one of these conferences, held jointly by the University and the Carnegie Institution of Washington, that Dr. Niels Bohr, of Copenhagen, made this announcement.

During the war, University research included administration of a rocket plant near Cumberland, Maryland, where the Bazooka and other strategic weapons were developed.

The president of the University is assisted by a vice-president, Maj. Gen. Ulysses S. Grant, III. The Board of Trustees includes such distinguished contributors to science as Gilbert Grosvenor, editor-in-chief of the *National Geographic Magazine*; Alexander Wetmore, secretary of the Smithsonian Institution; and Charles Stanley White, surgeon.

Georgetown University

Simultaneously with the adoption of the Constitution of the United States in 1789, John Carroll, kinsman of the signer of the Declaration of Independence and first Archbishop of Baltimore, established Georgetown University. In 1805 the administration of Georgetown University was transferred to the Society of Jesus. In 1815 the University was chartered by Act of Congress; in 1833, empowered by the Holy See to grant degrees in Theology and Philosophy as a Pontifical University; and in 1844, incorporated by Act of Congress. The Graduate School dates from 1820; the Astronomical Observatory, from 1843; the School of Medicine, from 1851; the School of Law, from 1870; the University Hospital, from 1898; the Dental School, from 1901; the Training School for Nurses, from 1903; the Seismic Observatory, from 1911; and the School of Foreign Service, from 1919.

The purpose of Georgetown's professional education departments is to impart high ethical ideals united with a comprehensive technical training in the legal, diplomatic, medical, dental, and nursing professions within a realistic social perspective.

The purpose of Georgetown's Graduate School is to provide the student the opportunity to enter into an atmosphere of inquiry and research in the natural and social sciences, political and moral philosophy. In fields of study leading to the doctorate, research activity is patterned after a fabric having the principles of scholastic philosophy as its warp and the scientific method as its woof.

The University is administered by the president, Very Rev. Lawrence C. Gorman, S.J., and Board of Directors composed of the dean or regent of each School within the University.

Notable scientific achievements and important investigations under way in the Graduate School include the following:

Astronomical Observatory—a study of the space distribution of stars in a small region of the constellation Cygnus; an investigation of the use of color excesses of

Cepheid variable stars for the determination of interstellar absorption at distances of one to two thousand parsecs; observations of the times of contacts of the total eclipse of May 20, 1947. Under way: a star-count analysis of a region north of the constellation Cygnus; an investigation of the color excesses of Cepheid variable stars in the southern Milky Way on plates taken with the Georgetown 3" and Mt. Wilson 5" cameras in Brazil in April and May of 1947 covering an extensive region through the constellations Centaurus, Crux, Carina, and Vela; an investigation of the energy from the sun at radio frequencies; a study of the photographic extinction for blue and red light with a check on the consistency of magnitude standards in several Harvard Standard Regions.

Seismological Observatory—special method of attack for deep-focus earthquakes, the development of new principles and techniques in connection with the stereographic projection in order to make its application to the problem of the seismologist speedier, more general, and at the same time to escape bad intersections (all completed).



Rev. Frederick W. Sohon, S. J., chairman of the Department of Mathematics and director of the Seismological Observatory, inspecting a Mainka bifilar seismograph. (Picture by Reni Photos.)

Biochemistry—development of precise and highly specific tests for cysteine and its congeners (cystine and glutathione) and methionine; highly specific tests for guanidine, asymmetrical dimethylguanidine, creatine, and creatinine; highly specific tests for various amines formed from amino acids by microorganisms. Under way: discriminating tests for streptomycin and its fission products; tests for penicillamine and penicillin; differentiation of alloxantin and alloxan by colorimetric tests and by the spectrophotometer; retardation of tryp-

tic digestion by food constituents such as dihydroxyphenylalanine; methods for the estimation of nicotinic acid; identification tests for various new antibiotics; a chemical warning test in cancer; intermediate metabolism of sugars.

Studies completed or currently being conducted in the Medical School include:

Anatomy—analytic study of nuclear configuration of the thalamus and subthalamus; volumetric analysis of the cerebellar nuclei; volumetric analysis and cytoarchitectural analysis of the primate lateral geniculate body; cytoarchitectural analysis of the primate visual cortex. Under way: anatomical substratum of color vision; anatomical study of afferency in the sympathetic innervation of the extremities; histological analysis of brain tumors; cytoarchitectural analysis of the mammalian inferior olive; effect of age on the degeneration and regeneration of peripheral nerves.

Physiology—the physiological effects and isolation of a new embryonic androgenic hormone; physiological effects of light on the reproductive tract; synergistic effects of progesterone and testosterone on the female reproductive tract; possible mechanism of cocaine action as a local anesthetic in blocking pain; medium concentration in relation to the water content and electrical properties of nerve; effects of increasing osmotic pressure on growth and respiration of protozoa cultures; acetate metabolism in flagellates; maintenance of mean pulmonary arterial pressure after extreme right ventricular damage; effects on respiration of compression of the thorax; physiological effects of the parathyroid glands during embryonic development (all under way).

Medicine—establishment of endocrine laboratory and metabolic ward for research on the endocrine and metabolic aspects of cancer; establishment of bacteriologic research laboratory for the study of the newer antibiotics.

Pharmacology—colorimetric tests for the detection of barbiturates, the study of the antidotal effect and clinical life-saving use of pierotoxin and metrazol in barbiturate poisoning. Under way: the use of drugs in the study of development and in regeneration; the mechanism of action of cholinesterase, cholinesterase inhibitors, and sympathetic and parasympathetic blocking agents.

Anesthesiology—development of the hypospray or jet gun for administration of penicillin, streptomycin, various sedatives, stimulants, and local anesthetics. Under way: use of the hypospray for administration of radioactive isotopes experimentally in animals; research on certain vasopressor and vasoconstrictor drugs; nutritional studies dealing with various types of protein therapy utilizing various preparations of essential amino acids; the use of fluorine as an anesthetic agent.

Biological Chemistry—the rate of absorption of amino acids and their value in nutrition, including nitrogen balance studies in humans and animals; the action of the enzyme pepsin on casein and other proteins; development of methods for separation and determination of androsterone and testosterone and their utilization in studies of the blood of individuals receiving these hormones for the treatment of endocrine and metabolic disturbances;

isolation of the protein of dental enamel from normal and carious teeth; studies on the enzyme activity and hydrogen-ion concentration of human saliva; investigation of the ascorbic acid content of saliva from normal and carious mouths (all under way).

Bacteriology—the effect of streptomycin on histoplasma capsulatum, an attempt to evaluate the role of streptomycin as a therapeutic drug; the cultivation of *Neisseriae gonorrhoeae* in synthetic media (all under way).

Röntgenology—study of the normal and pathological physiology of the gastrointestinal tract with particular reference to the physiology of the mucosal pattern; the use of bronchograms in the study of the chest to discover the early stage of bronchogenic carcinoma; co-operation with the Cancer Detection Clinic to find the early stage of cancer in the body (all under way).

Radioactive Isotope Research—the study of the introduction and distribution of newer compounds of calcium in the animal by means of radioactive calcium (Ca^{45}) as a tracer material; the use of radioactive phosphorus (P^{32}) in the treatment of polycythemia vera; the use of the hypospray gun in radioactive calcium (Ca^{45}) tracer work for pattern distribution and absorption rate of Ca^{45} ; the use of heavy metals as therapeutic agents in the treatment of cancer.

During the Centennial Celebration members and friends of the AAAS are invited to visit the Georgetown College Observatory to view a display including:

(1) A photographic mosaic of the entire Milky Way approximately $22' \times 3'$. The southern portion of this mosaic is made from the plates taken by the Georgetown astronomers in Brazil during April and May of 1947. All of the photographs were made with the same lens and camera.

(2) Three enlargements of the total eclipses of 1932, 1937, and 1947 which were taken with the Georgetown Ross type camera.

(3) The first instrument purchased by Georgetown in 1841.

(4) The diary of Georgetown Observatory, which was begun in 1841 by Fr. James Curley.

(5) Some rare old books of the original library of Georgetown Observatory, such as a first edition of Newton's *Principia*.

(6) Enlargements of one or two photographs of the Georgetown astronomers on different eclipse expeditions.

(7) A copy of a seismograph record showing an earthquake recording.

(8) Some photographs of ancient and modern seismographs.

American University

The American University, of which Paul F. Douglass is president, was incorporated by act of Congress on February 24, 1893. The purposes of the founders was to establish in Washington an institution devoted entirely to graduate studies which would incorporate into its program the opportunities and resources which exist in the national environment.

The American University, enrolling during the year almost 5,000 students, conducts its operations from two locations—a 75-acre wooded campus occupied chiefly by the College of Arts and Sciences and located in the north-west heights of Washington at Massachusetts and Nebraska Avenues, and the School of Social Sciences and Public Affairs, located on F Street between 19th and 20th Streets. The School of Social Sciences and Public Affairs is organized in an undergraduate and graduate division. The Graduate Division carries forward the original purposes of the University. Graduate instruction is limited to the social sciences in the fields of communication, economics, history, international relations and organization, public administration, political science, sociology and public welfare, and statistics.

The major research of the University is devoted to the study of the interaction of government, business, and administration at the point where the definition of sound policies creates the need for competent administration.

The University is in the process of completing plans for the construction of a new Public Affairs Center to extend from 19th to 20th Streets on F Street, midway between the White House and the Department of State.

The University of Maryland

The University of Maryland, a sprawling educational center straddling the Washington-Baltimore Boulevard 10 miles north of the Nation's capital is in the middle of a \$16,000,000 building program that will give it one of the finest physical plants in the country.

Two of the oldest educational centers in the country are incorporated into the history of the University of Maryland, the Maryland Medical School, organized as the College of Physicians and Surgeons in Baltimore in 1807, and the Maryland Agricultural College, chartered at College Park in 1856.

The steady individual growth and recognition of the two institutions led to their merger as the University of Maryland in 1920. The school now has two branches, with Medicine, Law, Pharmacy, and Dentistry located in Baltimore, and Agriculture, Arts and Sciences, Business and Public Administration, Education, Engineering, Home Economics, Military Science, Physical Education, Recreation, and Graduate Studies located at College Park.

Today the University has an enrollment of over 11,000 (nearly four times the prewar enrollment) and is increasing its facilities to accommodate the estimated permanent student body of about 10,000.

President H. C. Byrd, one of the state's best known and most colorful personalities, greeted the postwar boom in education with the announcement that everybody who is qualified and who wants an education should be accorded the opportunity to obtain one. Forthwith he directed all of the facilities of the University of Maryland toward that end.

Scientifically, the university has made innumerable contributions to both the state and the country, and its vast laboratories and research departments are never idle.

Foremost on the list of recent construction is the Glen L. Martin wind tunnel, completed this summer at a cost

of over \$1,000,000. The tunnel will be the center of government and private research in aeronautics. With wind velocities up to 300 mph and a capacity for handling models with wing spans of 8', the tunnel is one of the most efficient of its type. It is equipped with new-type IBM machines for computation and reduction of data obtained in tests.

Among the University's most recent and outstanding contributions to science is the development of the new antimalarial, pentaquin, by Nathan Drake and his staff of the Chemistry Department. The new drug, known as SN-13276, was discovered during the war. It is more active and from one-third to one-half less toxic than pomaquine, a drug discovered by the Germans which formerly was the chief antimalarial used.

Perhaps the most intensive research is carried out by the College of Agriculture and the State Extension Service under the direction of T. B. Symons. A day does not go by that a new development is not announced that will make the life of Maryland's thousands of farmers either easier or more profitable.

Experiments are currently under way in the Physics Department on the measurement of specific heat at high temperatures, on cosmic radiation, and on physics in the solid state.

The University of Maryland rapidly is reaching the peak of its physical development, but its scientific contributions will continue to grow with the new facilities that are becoming available with every new building that is added.

The Office of Naval Research

On May 19, 1945, the U. S. Navy began putting into effect the most extensive peacetime scientific research program ever undertaken. Almost three months before the atom bomb fell in Hiroshima, Secretary of the Navy Forrestal established the Office of Research and Inventions to assure the Navy a well-coordinated research effort in every field of basic science.

Renamed the Office of Naval Research and given statutory permanence by Congress under Public Law 588 in August 1946, it is now headed by Rear Adm. Paul F. Lee, USN, who is assisted by Capt. C. M. Bolster, USN, deputy and assistant chief, and Alan T. Waterman, deputy and chief scientist. The office now has under way far-reaching research programs in the following physical sciences: nuclear physics, physics, chemistry, electronics, mechanics and materials, geophysics, fluid mechanics, and mathe-

matics. The medical sciences are also a part of the program and include human ecology, physiology, biochemistry, microbiology, psychophysiology, psychology, biophysics, and dentistry. In the naval sciences, research is progressing in undersea warfare. The Research Group, directed by Capt. W. H. Leahy, USN, is responsible for the initiation and supervision of the research program.

Virtually every outstanding scientific laboratory in the country, whether it be part of a big industrial plant or part of a university's science department, is working on some phase of the research program of ONR. Leading scientists of the country are guiding this tremendous scientific effort in the interests of the Navy and the national security.

ONR maintains at Navy Department headquarters in Washington and also in branch offices in key cities and in England a Research Group consisting of engineers, physicists, chemists, and mathematicians working closely together to insure an adequate program of fundamental research in the natural and applied sciences for the Navy. These scientists constantly review and appraise contracts for basic research with industrial laboratories, private research institutions, and universities.

To coordinate further the research activities of the Navy, the Naval Research Laboratory was made a part of ONR (see *Science*, August 20, p. 177).

The Special Devices Center, located at Sands Point, Long Island, and directed by Capt. George O'Rear, USN, is also part of ONR. It is responsible for the conduct of research and development in the fields of synthetic training and human engineering in order to find effective ways of teaching unskilled personnel how to use the new and complex weapons of the modern Navy. Its work consists basically of 5 major phases: synthetic training devices, research in human engineering, development of research tools, tactical evaluators, and teaching aids.

A nation is no stronger than the strength of the scientific core from which it can draw in times of emergency. As Mr. Forrestal said in establishing the Office of Naval Research: "Wars are fought primarily with weapons which are developed before the fighting begins. . . . If a nation is to be scientifically prepared, its preparedness must be worked out in peacetime."

The Navy's long interest in science and its years of systematic research are proof that it has long believed in being scientifically prepared. The Navy's responsibility for the national security makes it imperative that it constantly explore all fields of science for the new powers which scientific research may bring.

The General Electric Company held a Whitney Day Ceremony on August 21 at its new Research Laboratory in Schenectady in honor of the 80th birthday of Willis Rodney Whitney, founder of the laboratory and its director from 1900 to 1932. The ceremonies began with a tour of the laboratory, and this was followed by an assembly in the foyer with speeches by C. G. Suits, vice-president and director of research; L. A. Hawkins, consultant; W. D. Coolidge, director emeritus of the laboratory and consultant; and E. A. Luebke, who spoke for the Whitney Club.

High light of the ceremony was the unveiling of a portrait of Dr. Whitney by Dr. Coolidge, his successor (see cover). Shown gathered around the portrait are (left to right) Dr. Suits, Dr. Whitney, Tran Mawicke (the artist), Dr. Coolidge, and Dr. Hawkins, the principal speaker on this occasion.

Comments and Communications

Anti-Rh Pseudoagglutinins in IV-6 Human Plasma Fraction

In a recent article (*Science*, May 28, pp. 571-572) some hematologic effects from the infusion of IV-6 human plasma fraction were described. We have since encountered anti-Rh pseudoagglutinins in samples of this fraction prepared from a plasma pool of 400 presumably normal donors. The concentration of anti-Rh factor in these samples was sufficiently high to render them utilisable as Rh testing antisera.

Although passive sensitization by Rh pseudoagglutinin in postnatal life has never been reported to our knowledge and although we have not observed such sensitization by the administration of solutions of IV-6 fraction, we nevertheless suggest that anyone contemplating the administration of this fraction test it beforehand for the presence of anti-Rh pseudoagglutinins. Should these prove to be present, it would seem advisable to remove such pseudoagglutinins prior to administration.

Anti-Rh pseudoagglutinin may be readily removed from human plasma fractions by the addition of successive portions of Rh-positive erythrocytes and the removal of the clumped masses of the latter by centrifugation.

We have found a similar blocking type anti-Rh pseudoagglutinin in glycoprotein fractions from hog parotid and hog stomach extracts.

GEORGE B. GORDON, HERBERT A. WEITZNER,
and ROBERT D. BARNARD

565 1st Street, Brooklyn, New York

Recent Developments in Weed Control

This article describes a method employed in Hawaiian weed control to supplement the desirable herbicidal effect of 2,4-D and to tame or reduce the injurious effect of this hormone upon sugar cane.

Depending upon pH, physical characteristics, and concentration of organic matter, Hawaiian soils react differently to normal pre-emergence applications of 2,4-D. In a number of middle-belt soils—pH range, 6.5-7.5—an application of 2,4-D at 2½ lbs/acre of soil surface will penetrate downward 3" or more without its suffering immediate fixation or decomposition. In such cases the hormone may reach the recently planted cane seedpieces, 3" below the soil surface, in amounts sufficient to repress or prevent their germination, or it may abort or distort root development and growth of cane shoots.

In other soils—pH, 6.0-7.0—of the heavy adobe type, as much as 25 lbs/acre of 2,4-D may be applied under similar circumstances with no observable detrimental effects whatsoever. In the first case cited, 2½ lbs of

2,4-D/acre may be found too light an application as a satisfactory inhibitor of weed and grass seed germination and growth of tender weed seedlings.

It has been found in such cases that the application of 2,4-D may be reduced to a concentration not harmful to germinating cane—say 2 lbs/acre—and the full pre-emergence herbicide effect on the field may be sustained three months or longer *provided* its action is supplemented by including with it about 5 times its weight of H.S.P.A. Activator (pentachlorophenol, or sodium pentachlorophenolate—U. S. Patent No. 2,370,349).

The activator does not injure the planted seedpiece or in any other manner adversely affect the growth and development of the crop as far as we have been able to detect. As a matter of fact, H.S.P.A. Activator alone, applied at 40 lbs/acre in pre-emergence, has been found entirely satisfactory for the purpose, although rather costly.

In a proposal which was made at the annual meeting of the Hawaiian Sugar Technologists in November 1947, it was suggested that it may be possible to discourage the downward movement of soluble 2,4-D in the soil by applying it in oil solution. A herbicide formula, based upon the amendments to 2,4-D discussed above and previously studied in the laboratory, was submitted in Honolulu to the assembled technologists at their meeting previously noted. The formula follows:

2,4-DAC¹

- 66 lbs of aromatic by-product petroleum oil²
- 10 " " oil-soluble H.S.P.A. Activator³
- 2½ " " isopropyl ester of 2,4-D
- 2 " " oil-soluble emulsifying agent⁴
- 80½ lbs (about 10 gals)

The activator is dissolved in the oil by the application of gentle heat. The ester is then added, followed by the emulsifying agent. Add the 10 gals of 2,4-DAC, with moderate stirring, to 90 gals of water, the latter containing .5% by weight of a conditioner⁵ consisting of an alkyl aryl sulphonate. This produces an excellent emulsion which remains stable for hours.

The 100 gals of diluted emulsion thus produced may be applied in pre-emergence to one acre of bare soil by ordinary spraying equipment. This art is currently in vogue as exclusive plantation practice on one sugar plantation on the Island of Hawaii.

Where modern spray nozzles are employed, the 10 gals of concentrated 2,4-DAC may be applied directly, without further dilution, or any convenient volume of water may be used to dilute the concentrate if so preferred.

¹ Indicating a combination of 2,4-D and oil-soluble H.S.P.A. Activator.

² Any highly aromatic, low-density, by-product oil, such as Union Oil Company's 4060-0, General Petroleum Company's 1408, Magnolia Petroleum Company's Sovacide 544-C, Pan American Refining Company's A-383, etc.

³ Pentachlorophenol.

⁴ Any suitable emulsifier of the alkylated aryl polyether alcohol group.

⁵ Santomerse 3, or 2-7-R Wetting Agent.

This formula, diluted with water, has been found particularly efficacious when employed as a pre-emergence and as a contact application on areas where planned treatment has inadvertently been postponed. We may assume that the postponement allows weed and grass growth to reach a height of about 1". In such cases a somewhat heavier application in slightly increased volume generally results in a very satisfactory control. The duration of effect may, and usually does, exceed a continuous period of three months.

Where 2,4-DAC is to be applied without dilution, it is not necessary, of course, to include the emulsifying agent in the formula.

FRANCIS E. HANCE

Experiment Station,

Hawaiian Sugar Planters' Association, Honolulu

The American-Soviet Science Society

As officers and former officers of the American-Soviet Science Society, we should like to make a statement concerning the way in which the work of the Society has brought to an end by the failure of the U. S. Treasury to grant us a tax exemption certificate as a nonprofit educational organization.

The Society, which was formed in 1945 as the successor to the Science Committee of the National Council of American-Soviet Friendship, has notified its members that it is unable at present to carry on its normal activities. It had been engaged in facilitating relations between scientists in the U.S.A. and U.S.S.R. through the publication of scientific articles by Russian authors in American journals, the circulation in the United States of scientific books, journals, and reprints from the U.S.S.R., and particularly by acquainting American scientists, through its "Bulletin," with scientific work published or in progress in the Soviet Union.

When the Society became an independent organization in May 1946 by severance of relations with the National Council of American-Soviet Friendship, it was realized that the small dues and contributions it was able to obtain would not suffice to support the extensive administrative and editorial work which had increased greatly since 1943 or to convert the "Bulletin" into the full-fledged *American Review of Soviet Science* which had been planned. Consequently, a grant for the support of this work of international exchange and publication was obtained from the Rockefeller Foundation in June 1946. It was known at the time that this grant could be paid only when the Society should be in possession of a tax-exemption certification from the U. S. Treasury; and it was assumed that since the Science Committee had enjoyed such status, it would be granted to the Society as a matter of course, following application in June 1946.

In making such an assumption the officers failed to reckon with the obstructive tactics by which for two years the Treasury Department has failed to act upon our application. The only reason given is contained in a letter from Mr. E. I. McLarney, Deputy Commissioner of Internal Revenue, dated April 28, 1947,

who stated: "It appears from newspaper articles recently published that the Committee on Un-American Activities of the House of Representatives proposes to investigate the matter of whether your activities and those of certain of your leaders are detrimental to the interests of the United States. Under these circumstances a definite ruling on your status for Federal income tax purposes is being deferred pending further development of facts."

The "newspaper articles" were those concerned with the campaign waged by the Un-American Activities ("Thomas") Committee of the House against Dr. Edward U. Condon, director of the Bureau of Standards, who had been a member of the Executive Committee of the American-Soviet Science Society. The Society has never been on the so-called "subversive list" of the Attorney General, and no grounds whatever exist for any suspicion concerning the motives or actions of its officers in connection with American-Soviet scientific exchange. In common with other organizations striving to improve American-Soviet relations, its work has been hampered by the atmosphere of suspicion created by the Thomas Committee, which, in the absence of any inquiry, has by insinuation alone sufficiently influenced a department of the Government to prevent our receiving the material support needed for our work. This has taken place in spite of the approval given to the Society's scientific exchange service by American scientists, by libraries, by many government bureaus and departments which have used our service, by the Rockefeller Foundation, and by the State of New York, under whose laws the Society is incorporated as an educational organization. It is a sad commentary on the administration of a government department that it prefers unsubstantiated insinuations to these solid evidences of the scientific standing of the Society and its value to American science.

L. C. DUNN, *President,*

American-Soviet Science Society, until May 1946

HARLOW SHAPLEY, *Honorary President*

ALICE HAMILTON, *Honorary Vice-President*

LEO LOEB, *Honorary Vice-President*

DUNCAN A. MACINNES, *President,*

American-Soviet Science Society, Inc.

On the Number of Genes in Man

Reliable determination of the number of separate gene loci has not been made for any organism. For experimental forms, especially *Drosophila*, rough approximations are established (e.g. J. W. Gowen and E. H. Gay. *Genetics*, 1933, 18, 1-31; D. E. Lea. *J. Genetics*, 1940, 39, 181-188; H. J. Muller. *Proc. int. Congr. plant Sci.*, 1929, 1, 897-921). Although ideally controlled experimental results are not available, considerable theoretical interest attaches to the problem of gene number in man. For instance, the tempo of human evolution is, among other things, a function of the number of gene loci susceptible to mutation (S. Wright. *Bull. Amer. math. Soc.*, 1942, 48, 223-246). Another source of interest is that an estimate of gene number in man illustrates the

magnitude of the task for a "complete" human genetics. Even rough approximations are here relevant.

Estimates now available on the number of gene loci in man are based on argument by analogy from *Drosophila*. These arguments employ a single human datum, chromosome number. J. S. Huxley (*Evolution, the modern synthesis*. New York: Harper, 1943. P. 50), to cite a single case, suggests that man has 4-6 times the gene number of the fruit fly (where published estimates vary by a factor of about 6.5)—that is, a minimum of 8,000 to a maximum of 78,000. Sample sources of error in such arguments are the assumptions that human and *Drosophila* chromosomes contain the same mean number of genes and that they contain equal amounts of genetically inert material.

This note outlines two approaches to the problem of gene number using additional data specified on man. Individually, neither approach is fully satisfactory. Together they provide an interesting, but highly speculative, approximation.

(1) In *Drosophila* the total haploid chromosomal length with the X is about 6.85×10^{-4} cm (Gowen and Gay). Assume that the fruit fly has 5,000 genes (salivary chromosomal data; C. B. Bridges. *J. Heredity*, 1935, 26, 60-64); each gene would "occupy" an average of 13.7 units of this length. Evans and Swezy (*Mem. Univ. Calif.*, 1929, 9, 1-41) have measured the mean total length of all chromosomes in 10 late prophase nuclei from various tissues from 4 humans. Measurements by Andres and Navashin (*Proc. Maxim Gorky med.-genet. Res. Inst.*, 1936, 4, 506-524) provide nearly equivalent results for the 10 largest chromosomes from several individuals. These data suggest that the total haploid length in man, at a division stage roughly comparable to the *Drosophila* data, is about 58.46×10^{-4} cm. Letting human and *Drosophila* genes occupy the same mean chromosomal length, man would have a little over 42,000 gene loci.

(2) The notion of lethal mutation permits a second estimate. Assume that 22% of all conceptions terminate in nonviable offspring (A. H. Schultz. *Contr. Embryol.* (Carnegie Instn Wash. Publ. No. 275), 1921, 56, 177-191). This value is a little higher than the mean of 9 estimates by other workers ranging from 14% to 30.3% (A. S. Parkes. *Eugenics Rev.*, 1926, 17, 275-293). Of such abortus assume a sex ratio of 120.25 (Schultz)—a value somewhat lower than that (133.03) obtained by Ciocco (*Human Biol.*, 1938, 10, 36-64, 235-250) for stillbirths; in 27 estimates by various other workers this ratio ranges from 101 to 229 males for each 100 females (Parkes). Among these abortus, assume that the excess of males, E , amounting to 2.04% of all conceptions, is due to lethal mutations in the nonhomologous portion of the X—the chief chromosomal differential (together with the relatively small, nonhomologous region of the Y) between individual males and females. Statistical evidence strongly indicates the occurrence of such sex-linked lethals in man (C. C. Little and M. Gibbons. *Proc. Soc. exp. Biol. Med.*, 1921, 18, 111-115). If each locus in the nonhomologous part of the X mutates to lethal at a rate, r , of 1 in 50,000 conceptions (the

approximate mutation rate for the normal sex-linked gene to its allele for hemophilia; J. B. S. Haldane. *J. Genetics*, 1935, 31, 317-326), then the number of loci, n , in the nonhomologous portion of the X, is given by $n = rE = 1,020$. It requires mention that small changes in the values of E and r will make for large differences in the value of n . More reliable data on aborted and stillborn fetuses in man (Ciocco; C. C. Little. In Mueller, Little, and Snyder's *Genetics, medicine, and medicine*. Ithaca: Cornell Univ. Press, 1947. P. 71) and on mutation rates are much to be desired. On the assumption of a higher sex ratio for abortus, say 133.03 (Ciocco the value of n becomes 1,560. An estimate of 1,000-1,500 sex-linked loci is in some accordance with indications from data for the sex-linked loci of myopic nightblindness and deuteranopia that the nonhomologous portion of the X is genetically "long"—that is, nearly 50 cross-over units in length (T. White. *J. Genetics*, 1940, 40, 403-438).

The cytological length of the X chromosome in man is about 4.5μ ; the nonhomologous segment is about $2/3$ the total length (P. C. Koller. *Proc. roy. Soc. Edinb.*, 1937, 57, 194-214). The ratio of the nonhomologous portion of the X to total haploid chromosomal length is of the order 1:19.5. On the basis of these speculations there are then some 19,890-30,420 gene loci in man.

The above two independent approaches suggest that the number of gene loci in man is of the order 20,000-42,000.

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On the Solubility of Fibrin Clots

It is generally assumed that the fibrin clot formed by the action of thrombin in fibrinogen solutions or in oxalated plasma is the same as that formed during blood clotting or during the clotting of recalcinated plasma by its own thrombin. There are, however, marked differences between fibrin clots with respect to their solubilities. A clot obtained in purified fibrinogen solution or in oxalated plasma by the action of purified thrombin dissolves readily when an equal volume of 60% urea is added to the clot. The clot formed in recalcinated plasma by its own thrombin, however, does not dissolve in urea solution.

It was found that two factors together are responsible for rendering the clot insoluble in urea solution: one is the calcium ions and the other is some serum component which seems to be thermolabile. Adding these two factors in sufficient concentrations to purified fibrinogen prior to the addition of thrombin, the clot formed will be insoluble. Neither the calcium ions nor oxalated serum alone renders the clot insoluble. The observations are in accordance with the results of Kennerly and C. Robbins (*Amer. J. Physiol.*, 1944, 142, 581), who studied the solubility of fibrin in weak acids and alkalis.

A detailed account of this work will appear shortly in *Acta Physiologica Hungarica*.

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The Antirheumatic Effect of Sodium Gentisate

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The mechanisms involved in the activity of rheumatic diseases are as unknown as is the rationale of the anti-rheumatic action of salicylate. Salicylate administration has been shown to inhibit the spreading effect of hyaluronase (1). *In vitro*, however, salicylate inhibits hyaluronase in very high concentrations only, whereas the biological oxidation product of salicylate, gentisic acid, does *in vitro* in concentrations of a few $\mu\text{g}/\text{ml}$ (3). The activation of the enzyme is apparently irreversible and believed to be due to a condensation of the semiquinone with the enzyme protein.

Since increased hyaluronidase activity has been suggested as a possible cause of the breakdown of inter-vascular cement in rheumatic diseases (2), the anti-rheumatic action of Na gentisate (supplied by Hoffmann-La Roche, Inc., Nutley, New Jersey) has been investigated in a small number of patients. The results have been sufficiently uniform to warrant the present report. Gentisate has the same antirheumatic effect as salicylate without one of its disadvantages. In 5 patients with acute rheumatic fever, the administration of Na gentisate in doses comparable to those customarily employed for salicylate has been followed by disappearance of pain, swelling, and heat in the joints, by the fall of temperature to normal, and by fall in sedimentation rate. In one patient, withdrawal of gentisate after 3 days of administration was followed within 44 hrs by a return of joint symptoms, which again responded promptly to renewed administration of gentisate. The joint pain in 7 patients with rheumatoid arthritis has responded similarly to gentisate as to equivalent amounts of salicylate. In one patient, the salicylate was not tolerated because of the co-existence of a chronic duodenal ulcer, whereas gentisate caused no gastric irritation. Four patients with persistently active rheumatic fever—so-called "chronic rheumatic fever"—have responded similarly to gentisate and salicylate.

No untoward effects have been observed in the patients given as much as 10 gm/day, save in one patient who, on 15 gm/day, developed some epigastric distress which subsided immediately on withdrawal of the gentisate. No significant increase in prothrombin time, no tinnitus or other symptoms have developed. No sign of methemo-

globinemia or of liver damage has been observed. It seems significant that the increase in urinary glucuronic acid excretion observed with salicylate ingestion (4) does not occur with gentisate.

Only about one-quarter of the gentisate ingested was recovered in the urine as gentisic acid. So far we have been unable to detect gentisic acid in the blood, using a color method by which 5 γ/cc of hydroquinone in the urine can be detected. It appears that gentisate is rapidly oxidized in the body.

In summary, sodium gentisate appears to exert anti-rheumatic activity equal to, or greater than, that of salicylate. It is suggested that the antirheumatic action of salicylate is due to its oxidation product, gentisate. A detailed report of this work will be published shortly.

References

1. GUERRA, F. *J. Pharm. exp. Therap.*, 1943, **87**, 1946.
2. MEYER, K., and RAGAN, C. *Mod. Concepts card. Dis.*, 1948, **17**, 2.
3. MEYER, K., RAGAN, C., and WEINSHILBAUM, H. *Fed. Proc.*, 1948, **7**, 173.
4. QUICK, A. J. *J. biol. Chem.*, 1933, **101**, 475.

Does Glutamic Acid Have Any Effect on Learning?

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Recent studies of the role of glutamic acid in learning and intellectual capacities have presented a picture of conflicting findings. Following a clinical report (6) that the feeding of excess glutamic acid to epileptic children seemed to improve their 'mental alertness,' Zimmerman and Ross (9) did a controlled study on the learning ability of albino rats of the Sherman strain. They found that feeding either proline or glutamic acid in 200-mg doses in excess of a basic chick Growena diet resulted in a superior performance of these animals on a Warner-Warden, 8-cul, single alternation maze. Later, Albert and Warden (2) reported that excess glutamic acid had beneficial effects on the performance of rats in a complex reasoning problem. Furthermore, extension of this work to humans in studies of feeble-minded children has suggested that excess glutamic acid intake can increase the IQ as measured by standard intelligence tests (1, 7, 8). Since the earlier animal studies, however, two reports have appeared which failed to demonstrate any effects of glutamic acid on the rate of learning or in the reasoning ability of the albino rat. Marx (5) found no difference between glutamic-fed and control animals in the learning of a Stone multiple-T water maze. Hamilton and Maher (3) reported that glutamic acid feeding did not result

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in a higher level of performance of rats on the Maier three-table test of reasoning.

These negative results, however, cannot be taken as disproof of the positive effect of glutamic acid which has been reported, for in each experiment there were differences in procedure with respect to a number of important variables: basic diet used to maintain experimental and control animals, amount of excess glutamic acid administered daily, portion of the life span covered by experimental feeding, age and strain of animals, and type of learning or reasoning tests used. At best, the negative findings indicate that beneficial effects of glutamic acid administration are not general to all procedures, strains, dosages, ages, and tests or some combination of these.

TABLE 1
MEAN PERFORMANCE ON WARNER-WARDEN SINGLE ALTERNATION MAZE (8 CULS)

	N	No. of trials	Trials to meet criterion		Total errors		Total time (sec)	
			M	σ	M	σ	M	σ
Control	14	21	5.1	4.0	11.4	4.5	663	568
Glutamic	14	21	5.1	2.3	14.2	4.8	597	287

It was decided, therefore, to duplicate, as nearly as possible, the most clear-cut of the positive findings with glutamic acid in order to demonstrate clearly, its proper role in learning ability. To this end, the procedures of Zimmerman and Ross were followed in every detail except for the strain of animals used. Twenty-eight pigmented rats from the Johns Hopkins colony (descendants of the Lashley strain) were divided into two groups of 14 animals each, matched for sex, weight, and litter. At the age of 6 weeks, all animals were taken off the colony diet of Purina Fox Chow checkers, which they had had *ad libitum*, and were placed on a 24-hr feeding schedule in which they had access to a Growena chick mash for 1 hr a day in individual feeding cages. Before each hour of daily feeding, the experimental animals were given a 5-gm dish of the basic diet, containing 200 mg of neutralized 1 (+) glutamic acid. The control animals had the extra 5-gm meal but never received any glutamic acid supplement. This feeding procedure was maintained throughout the entire experiment. All animals were weighed each day before feeding.

After 10 days of glutamic acid feeding, both control and experimental rats were allowed daily sessions of preliminary exploration of the disconnected maze units for 4 days. At the end of this time, each rat was given one trial daily in the connected maze for 21 days. The order in which animals were tested each day was maintained throughout the experiment. Furthermore, to avoid artifacts of procedure, experimental and control animals were alternated on the maze runs throughout each session.

The results of this experimental duplication of the study of Zimmerman and Ross indicated *no difference in the maze performance of control and glutamic-fed ani-*

mals (Table 1). Statistical analysis indicates that total time and error scores and the number of trials required to reach a criterion of 4 out of 5 errorless runs were essentially the same in each group. In fact, both groups of animals learned the maze about as fast as Zimmerman and Ross's glutamic-fed animals. Growth curves for each group of rats were virtually identical.

Since it appeared that the Warner-Warden maze might be too easy a test to differentiate between normal and glutamic-fed animals of our strain, the rats were continued on the experimental feeding regime and were subsequently tested on two mazes of increasing difficulty: the Warner-Warden double alternation maze (8 culs) and a 4-cul, double alternation, elevated maze used by Hummel (4). In the former test, smell cues were eliminated

TABLE 2
MEAN PERFORMANCE ON WARNER-WARDEN DOUBLE ALTERNATION MAZE (8 CULS)

	N	No. of trials	Trials to meet criterion		Total errors		Total time (sec)	
			M	σ	M	σ	M	σ
Control	14	11	5.4	3.3	13.4	5.9	514	338
Glutamic	14	11	5.9	2.3	15.1	3.6	338	110

TABLE 3
MEAN PERFORMANCE ON ELEVATED DOUBLE ALTERNATION MAZE (4 CULS)

	N	No. of trials	Total errors		Total time (sec)	
			M	σ	M	σ
Control	14	24	35.5	3.4	513	110
Glutamic	14	24	35.6	6.6	458	140

spraying the maze with cresol between the runs of individual animals. In the latter test, the units of the maze were rotated and interchanged between trials, but the animals were not blinded.

Even in these more difficult tests, *no difference could be detected between experimental and control animals with respect to errors, time, or number of trials to reach criterion* (Tables 2 and 3).

In view of these findings it must be concluded that there is no effect of excess glutamic acid on the maze learning ability of our strain of rats. It appears clear that the facilitating effects of glutamic acid on learning that have been reported are not general. Because of the controls we used, it is not likely that the positive results can be considered some function of the basic diet used, the age of the animals, the type of behavioral test employed, or the dosages of glutamic acid, although variation in any one of these variables could conceivably have affected results obtained in such an experiment. Since differences remain as the only possible variable that could account for the difference in results between our experiment and that of Zimmerman and Ross. Other negative

Results with albino rats indicate that the strain difference is not a matter of whether the rats are albino or pigmented, but it is possible that the beneficial effects of glutamic acid might be specific to the Sherman strain albino rats. At the present time experiments are being designed to test animals of the Sherman strain. Further experiments will be done in which proline and other compounds metabolically related to glutamic acid will be studied. At this point, however, it must be concluded that there is little evidence for a facilitating effect of excess glutamic acid feeding on the learning ability of the rat.

References

- ALBERT, K., HOCH, P., and WAELSCH, H. *J. nerv. ment. Dis.*, 1946, **104**, 263-274.
 ALBERT, K. E., and WARDEN, C. J. *Science*, 1944, **100**, 476.
 HAMILTON, H. C., and MAHER, E. B. *J. comp. physiol. Psychol.*, 1947, **40**, 463-468.
 HUNTER, W. S., and HALL, B. E. *J. comp. Psychol.*, 1941, **32**, 253-266.
 MARX, M. H. *J. comp. physiol. Psychol.*, 1948, **41**, 82-92.
 PRICE, C. J., WAELSCH, H., and PUTNAM, T. J. *J.A.M.A.*, 1943, **122**, 1153-1156.
 ZIMMERMAN, F. T., BURGEMEISTER, B. B., and PUTNAM, T. J. *Arch. Neurol. Psychiat.*, 1946, **56**, 489-506.
 ZIMMERMAN, F. T., BURGEMEISTER, B. B., and PUTNAM, T. J. *Psychosom. Med.*, 1947, **9**, 175-183.
 ZIMMERMAN, F. T., and ROSS, S. *Arch. Neurol. Psychiat.*, 1944, **51**, 446-451.

sions. We used venous occlusions exclusively, since the process was usually more gradual than in the arterial occlusions and could be followed more closely.

All observations were made on mesenteric vessels, using a Kniseley fused quartz rod transillumination apparatus (1) employing a constant-temperature tissue bath with variable volume flow. Young, small dogs were used, and intravenous Nembutal anesthesia was employed. A special Lucite tray held the dog's mesentery in a nonstretched position, submersed in constantly circulating mammalian Ringer's solution at body temperature. The microscope was fixed on small vessels. A small precapillary artery and vein running side by side were chosen for observation, the artery measuring from .054 to .144 mm in the various animals and the vein from .090 to .288 mm. The capillaries stemming from such vessels were observed in the same microscopic field.

In over 70 main-stem venous occlusions done on normal dogs we had consistently noticed sludge formation in the small vessels within 10-20 min following occlusion. Six animals in this group, chosen at random, comprised our control series. A second group of 6 animals was used in a preliminary experiment in which heparin was given by intravenous injection into a tongue vein after sludge formation was noted. A third group of 6 animals was heparinized before venous occlusion, while a fourth group of 6 animals was dicoumarolized before venous occlusion.

Group I: Control. The portal vein or superior mesenteric vein was occluded in the usual manner by a rubber-tipped clamp which was allowed to remain in place for about 1 hr before release. As the stream slowed and anoxia progressed, sludge formation was noted in each instance within 10-20 min in the small peripheral mesenteric vessels. As the stream slowed further, thrombus formation was noted in some of the small vessels, especially in the capillaries and venules, usually within 30 min after the appearance of sludge. The groups of agglutinated cells traveled in spurts through the spastic artery, while in the vein they became attached sooner or later to the endothelial lining of the vessel. As a small group of cells became adherent to the side of the vessel, more cells became attached to the mass, and a thrombus formed which eventually obliterated the entire lumen as the stream stopped flowing. In many instances, if the occlusion was released at this stage, flow again resulted as the liquid stream washed the agglutinated particles through. Other small vessels maintained their thrombosis and did not become patent. For the most part, by the time of release (about 1 hr), the flow had either ceased completely or was in the ebbing stage within most small vessels. After release of the occlusion, the vessels not showing renewed motion of the stream were considered thrombosed.

The process of thrombosis, then, in the small vessels under microscopic observation appeared to consist of the following steps: (a) sludge formation, (b) adherence of sludged masses to the endothelial lining of the vessels, (c) the "piling up" of more cells to such an agglutinated mass, and (d) stoppage of flow after complete occlusion of the vessel by an agglutinated mass of cells.

Group II: Heparin administered after the appearance of sludge formation. Using dogs of about 5 kilos, he-

Effect of Heparin and Dicoumarol on Sludge Formation

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Since Kniseley published his findings of the sludge phenomenon (2) in shock and certain other disease states has been assumed that this condition was a precursor of embolism, as evidenced by the following quotation from a recent editorial in the *Journal of the American Medical Association* (4):

As a result of publication of this report (Kniseley), many practicing physicians have suggested use of heparin or Dicoumarol to prevent the sludging of blood of patients met in their daily practices. Until these observations have been extensively checked by other investigators, introduction of new methods of treatment to combat sludging of blood should be only experimental.

In the course of vascular occlusion experiments in dogs, we found that we could produce sludge at will in smaller vessels distal to an occlusion within a relatively short time. Since our studies included an evaluation of various therapeutic agents in vascular occlusive diseases, we felt it necessary not only to determine the effects of anticoagulants on thrombus formation, but to investigate their effects on sludge formation as well.

Therefore, an experiment was set up to determine the effects of heparin and Dicoumarol on sludge formation in small vessels following acute main-stem venous occlu-

parin¹ was administered in doses ranging from 6 to 10 mg. The heparin was injected into a tongue vein as soon as sludge formation was noted following venous occlusion. In no instance was there any alteration in the nature of the sludge. However, it was noted that the clumps of sludged cells did not become adherent to the vessel wall as easily as in the control group. The sludged clumps built up in size until the vessel became almost occluded, but the mass did not become adherent to the endothelial lining. As a result, such masses rocked to and fro or flowed on in spurts. Occasionally such a mass, upon reaching a bifurcation, would split in two after being halted temporarily. Upon removal of the clamp, such vessels all resumed flow, and no thrombosis was observed.

Group III: Heparin administered before venous occlusion. Heparin was injected intravenously in doses ranging from .5 to 1 cc, depending on the weights of the dogs. This resulted in clotting times ranging from 15 to 28 min. After occlusion of the main vein, sludge formation was noted in each instance. Sludge appeared in from 9 to 35 min following occlusion. The stream slowed down in the usual manner but took considerably longer to stop completely than in the control series. In some instances there was considerable ebbing until the time of release. In the control series, as a rule, the majority of vessels were completely agglutinated within 30 min. In this series there was complete agglutination after 45 min in only one instance. In this case perhaps 25% of the vessels in the microscopic field were involved, the remainder maintaining patency. Except for this one instance, the sludged clumps of cells did not become adherent to the endothelial lining. Upon release of the occlusion, flow resumed in each instance, perhaps much more rapidly than in the control group.

It would thus appear that heparinization in clinically therapeutic dosages has no effect on sludge formation but will aid considerably in the prevention of thrombus formation around groups of sludged cells.

Group IV: Dicoumarol administered before venous occlusion. Six dogs were given adequate doses of Dicoumarol for a period of 3 days before the experiment. The doses ranged from 25 to 50 mg/day, depending upon the weights of the dogs. Prothrombin levels on diluted plasma, determined prior to occlusion, ranged from 15 to 20% of normal. Venous occlusions were made in the usual manner, and the small vessels were observed for sludge formation. Sludge appeared in each instance within 10-30 min. The appearance of the flow after approximately 1 hr was no different from that described in the heparinized animals. Again, the sludged masses did not become adherent to the endothelial lining and seemed to break up easily into smaller masses. In no case in this series was there any thrombus formation. Upon release of the occlusion, the blood within the small vessels resumed rapid flow.

Dicoumarolization therefore had no effect upon sludge formation but, as in the case of heparinization, prevented thrombus formation.

¹ Liquaemin, Roche-Organon, Inc., Nutley, New Jersey; 1 cc = 10 mg.

Our observations indicate that sludged masses of blood cells may serve as a matrix for thrombus formation, provided the other conditions favoring thrombosis are present. When anticoagulants are administered in doses known to be clinically effective, yet safe, thrombosis does not generally occur in the small vessels distal to an occlusion, but such doses do not prevent the formation of sludge.

The administration of anticoagulants prevents thrombus formation in the presence of sludge by preventing the sludged masses of cells from becoming adherent to the endothelial lining of the vessel. Although anticoagulants may cause some diminution in the tenacity of the adherence of the blood cells to one another, sludge formation, as such, is not prevented.

References

1. KNISELEY, M. H. *Anat. Rec.*, 1938, 71, 503.
2. KNISELEY, M. H., ELIOT, T. S., and BLOCH, E. H. *Arch. Surg.*, 1945, 51, 220-236.
3. LAUFMAN, H., MARTIN, W. B., and TUELL, S. W. *Gynec. Obstet.*, in press.
4. ———. *J.A.M.A.*, 1948, 136, 556.

An Experiment on Human Vitamin B₆ Deprivation¹

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For some years there have been reports of the successful therapeutic use of pyridoxin hydrochloride in several disorders and disease symptoms, some of which have accompanied a state of malnutrition. Whether in these cases the action of the compound accrued from any nutritive property is difficult to judge, mainly because of the magnitude of dosage. Under such conditions a pharmacological rather than a physiological action of vitamin should be considered, and interpretations of nutritional significance should be weighted accordingly.

The nutritional need of several organisms, including some mammals, for vitamin B₆ compounds has been established, and something is even known of their probable functions in metabolic processes. There is no direct evidence, however, that any of them are nutritionally essential for man, even though the ordinary human dietary supplies them in relative abundance.

Ancel Keys wrote: "... the only evidence which will accept as quantitatively exact on human requirements for B vitamins is that derived from controlled experiments on man. ... The needs for controlled experimental studies on man are glaring" (3).

We are reporting an investigation on the possible human need for vitamin B₆.

An experiment was carried out on an adult male (W. W. H.), who subsisted upon a purified diet and

¹ Supported by a grant from the Division of Medical Research of the National Research Council of Canada.

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all necessary known vitamins with the exception of B₆. The basal diet was a mixture of sucrose, corn oil, vitamin-free casein, mineral salts, and a cod-liver oil concentrate. Throughout most of the experimental period was taken in an amount to supply daily 2,178 Calories, 55% of which were supplied by carbohydrate, 26.3% by fat, and 15.2% by protein. The unpalatability of the mixture made difficult the ingestion of a sufficient amount to supply the caloric needs of a moderately active man. At this level, however, it supplied 82.5 gm of protein and 10 mg of iron/day. Thiamin hydrochloride, calcium pantothenate, nicotinic acid, riboflavin, ascorbic acid, choline chloride, and inositol were taken in amounts to satisfy recommendations and in the proportions used in comparable work on rats. An extract of rice polish concentrate from which pyridoxin had been removed by treatment with Filtrol was also included. The results of the experiment are summarized in Table 1.

Throughout the experiment there was no evidence of a marked disturbance in nitrogen balance. If a little more than a gram is added to each figure for daily urinary nitrogen output, to allow for fecal nitrogen, a slightly positive balance is always apparent after adjustment to diet. This indicates no impairment in nitrogen assimilation. Blood total nitrogen, nonprotein nitrogen, and amino nitrogen were followed. In none was there any significant change, and only the values for nonprotein nitrogen are included in Table 1.

TABLE 1

Regimen and exp. day*	Daily Calorie intake	Daily N intake (gm)	Daily urinary N output (gm)	Blood NPN (mg %)	Hb (gm %)	Leucocytes			Body wt. (lb)	Blood pressure (mm Hg)
						Total per mm ³	L (%)	N (%)		
2 3	2,905	15.75	14.00	33.6	16.0	7,400	27	67	129	130/90
			12.46	32.6	16.1					
	2,178	11.81	13.60	32.5	15.4	6,900	38	57	130	120/82
					15.9	5,920	46	44	124½	
						6,270	47	49	123½	
			10.19	34.0	15.8	8,800	53	40	122	110/76
3						8,240	35	58	121	110/68
5			10.44	32.6	14.2	8,990	36	59		
7					14.8	6,600	31	65	120½	110/76
10									122½	120/70
38					15.1	7,720	35	60		
50					15.0				129	

*1=purified diet without B₆; 2=purified diet with 10 mg of B₆/day; 3=ordinary diet.

The initial hemoglobin value ranged between 16 and 17 gm %. During the B₆-deprivation period it reached a lower level and fell still lower during the period upon the basal regimen supplemented with pyridoxin hydrochloride. It remained at this level for 4 months after the resumption of an ordinary diet.

Weight and blood pressure were not improved during the period of B₆ supplementation, but were after an ordinary diet was resumed. Their fall, and the accompanying tiredness, perhaps had resulted from the low caloric intake.

An albuminuria was noted when a test was done on

the 12th day of the B₆-free regimen. It remained at the one- to two-plus level for some time into the period of the ordinary diet. There was still a trace about 4 months

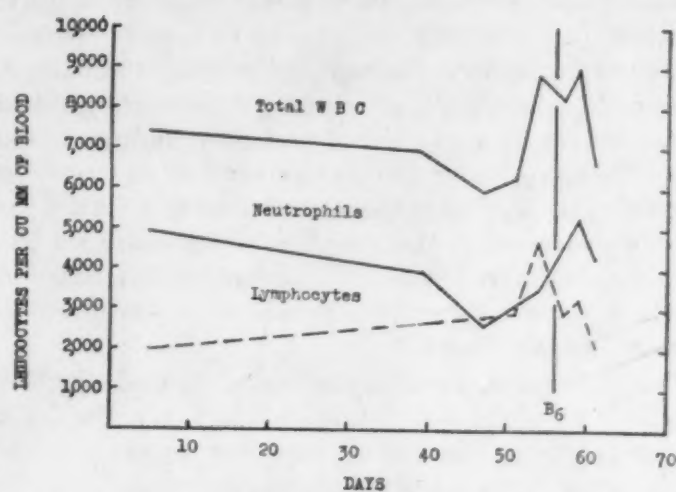


FIG. 1. The white blood cells during a human vitamin B₆-deprivation experiment. After 55 days without B₆ the diet was supplemented with pyridoxin hydrochloride.

afterward. A history of recurrent renal calculi complicates reference of this symptom to the vitamin deprivation.

Toward the end of the B₆-deprivation period the subject was aware of an unusual degree of depression and mental confusion, which disappeared very soon after

supplementation of the diet with pyridoxin hydrochloride. No evaluation of this phenomenon is, of course, possible, but it appeared sufficiently real to engender the opinion that, in any work on human B₆ deprivation, provision should be made for the detection of mental and nervous symptoms.

The most interesting observation was an alteration in the white blood-cell picture, involving the lymphocytes and neutrophils, with no changes among the other cells. A few days after the addition of pyridoxin hydrochloride to the regimen the original white blood-cell picture returned (Table 1 and Fig. 1).

An increase in the proportion of neutrophils and a decrease in the proportion of lymphocytes have been reported among the white blood cells of monkeys showing pathological symptoms after some time on a B₆-free regimen (4). In work on humans there are reports of rather rapid increases in neutrophils after the daily intravenous administration of 50–200 mg of pyridoxin hydrochloride in some cases of pernicious anemia showing a low leucocyte count (5) and in cases of agranulocytic angina (1). This is particularly interesting with regard to our observation. Much more experimental work must be done, however, before any physiological relationship between vitamin B₆ and the human white blood-cell picture can be postulated.

Our experiment revealed that on a purified diet, over a period of about two months without vitamin B₆, no changes occurred which could unequivocally be considered as resulting from a lack of those compounds. There is the possibility, however, of albuminuria, of mental symptoms, and of white blood-cell changes.

A longer experimental period would have been desirable. In the case of monkeys on essentially the same regimen, months have been required to produce B₆-deficiency symptoms (4).

There is a strong possibility that human intestinal bacteria synthesize vitamin B₆-active compounds (2). In human experimentation of this nature an intestinal antiseptic might be used to advantage. A more attractive possibility is the use of the antivitamin desoxypyridoxin when more is known of its toxic properties.

References

1. CANTOR, M. M., and SCOTT, J. W. *Science*, 1944, **100**, 545; *Canad. med. Ass. J.*, 1945, **52**, 368.
2. ELVEHJEM, C. A. *J. Amer. diet. Ass.*, 1946, **22**, 959.
3. KEYS, A. *J. Amer. diet. Ass.*, 1945, **21**, 211.
4. MCCALL, K. B., WAISMAN, H. A., ELVEHJEM, C. A., and JONES, E. S. *J. Nutrition*, 1946, **31**, 685.
5. VILTER, R. W., SCHIRO, H. S., and SPIES, T. D. *Nature, Lond.*, 1940, **145**, 388.

The Utilization of Carbon Dioxide by the Mature Rat in the Formation of Fatty Acids¹

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This report is concerned with the incorporation of C¹⁴ from carbon dioxide in the saturated and unsaturated fatty acids of the rat. The fatty acids were derived from previous experiments (1) in which two unfasted rats weighing 624 gm (Rat I) and 473 gm (Rat II) were given Na₂C¹⁴O₃ or CaC¹⁴O₃, respectively, by intraperitoneal administration. The purified total fatty acids were separated into saturated and unsaturated fractions

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(4, 5). The fatty acids were decarboxylated in a stream of nitrogen (2), and the evolved CO₂ was collected in saturated barium hydroxide. The unsaturated fatty acids were converted to the solid calcium salts before counting. Tracer experiments ruled out the possibility that C¹⁴ could have been incorporated chemically or mechanically in the samples.

TABLE 1

RELATIVE SPECIFIC ACTIVITIES OF THE C¹⁴ IN THE FATTY ACIDS OF MATURE RATS ADMINISTERED C¹⁴-LABELED CARBONATE*†

Sample	Rat I	Rat II
Total fatty acids	1.00 ± 0.1	1.00 ± 0.03
Carboxyl carbon of total fatty acids	2.04 ± 0.3
Saturated fatty acids	1.47 ± 0.08	1.47 ± 0.05
Carboxyl carbon of saturated fatty acids	2.74 ± 0.3	2.66 ± 0.3
Unsaturated fatty acids	0.63 ± 0.08	0.80 ± 0.04

* The actual specific activity (specific activity = % of total administered dose/mg of carbon) of the total fatty acids of Rat I is 0.56×10^{-6} and of Rat II, 1.06×10^{-6} .

† The deviation of the results shown in the table is derived from the statistical error of the radioactivity measurements and was taken as equal to the square root of the sum of the squares of the standard deviation of the sample and background counts.

The data given in Table 1 show that (a) a very small fraction in the carbon of administered CO₂ is incorporated in the saturated fatty acids and, to a lesser extent, in the unsaturated fatty acids; and (b) the C¹⁴ content of the carboxyl carbon atoms of the saturated and total fatty acids is approximately twice as high as the average of all the carbon atoms in the respective fatty acids. It is of interest to note that the specific activities of the C¹⁴ in the glycerol portions of the fat molecules were about 10 times greater than those of the corresponding mixed fatty acids (1).

Similar results were found by Rittenberg and Bloch (3) following the administration to rats and mice of acetic acid labeled at the carboxyl carbon atom with C¹⁴. They suggested that the C¹³ was present at alternate carbon atoms of the fatty acid chain, i.e. on the odd-numbered carbon atoms. Our results would indicate that the C¹⁴ activity derived from labeled CO₂ is also present on the odd carbon atoms of the fatty acids. The mechanisms through which this incorporation could take place can be derived from the interrelationships of the tricarboxylic acid cycle (6). Further evidence, particularly of the incorporation of the carbon of CO₂ into acetic acid, is needed to lend certitude to any one mechanism.

References

1. ARMSTRONG, W. D., SCHUBERT, J., and LINDENBAUM, A. *Proc. Soc. exp. Biol. Med.*, 1948, **68**, 233.
2. EASTERFIELD, T. I., and TAYLOR, C. L. *J. chem. Soc.*, 1911, **99**, 2298.
3. RITTENBERG, D., and BLOCH, K. *J. biol. Chem.*, 1945, **160**, 417.
4. SCHOENHEIMER, R., and RITTENBERG, D. *J. biol. Chem.*, 1936, **113**, 505.
5. TWITCHELL, E. *Ind. eng. Chem.*, 1921, **13**, 806.
6. WOOD, H. G. *Physiol. Rev.*, 1946, **26**, 198.

IN THE LABORATORY

The Radio Inductograph—A Device for Recording Physiological Activity in Unrestrained Animals

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The problem of distortion of a measurement by the application of the measuring instrument is common to many fields of science. For example, placing a thermometer in a liquid changes the temperature of the liquid if the two are not previously at the same temperature. If the liquid volume is large, the error will be insignificant, but if the volume is small, the thermometer is useless as a measuring instrument. Similarly, a physiological process may be affected by the process of measurement. It is

Inductograph has been developed in an effort to avoid this difficulty by utilizing a remote pickup from animal or human subjects.

This device uses physiological activity as a means of modulating a radio-frequency signal. The signal is detected and amplified by a special receiver whose output appears as a d-c potential, which is proportional to the frequency of the signal over a range of about 15 kc. This output may be used with a power amplifier and pen writer or with a suitable oscillograph to produce graphic records. A schematic diagram is shown in Fig. 1A. The system has great flexibility, and no attempt will be made in this paper to analyze it completely. The inductive pickups described below have great sensitivity and can be applied in devices which do not include a radio-frequency link. Thus, they may be applicable in other situations where a small movement or volume change is to be measured. A more detailed description and analysis will be presented later.

Four major components are included in the system:

(1) Pickup units² are of two types, pneumo-inductive and direct-inductive. Pneumatic pickups (Fig. 1B) may be actuated by balloons, capsules sealed over an artery, or pneumographs. These are connected by heavy-walled, fine-bore rubber tubing to an inducto-tambour located in the transmitter. The tambour contains the oscillator coil of the transmitter and carries a foil ring on its rubber diaphragm. Movements of this ring alter the inductance of the coil and frequency-modulate the R.F. signal. In the direct inductive pickups (Fig. 1C) the coil is located outside the transmitter, and the modulating ring is moved directly by the pulse or other physical movements.

(2) The transmitter is a simple, plate-tuned oscillator employing a 184 tube with plate and screen connected so that it acts as a triode. Power is supplied from a 45- or 67½-v B battery and a "pen-lite" dry cell. For use with the inductive pickups and external battery pack, the transmitter measures 3½" × 1½" × 1½". With a pneumatic pickup the length is increased to 4½" in order to accommodate the coil and tambour. The use of miniature B batteries designed for hearing aids permits enclosure of both batteries and transmitter in a larger case with an over-all reduction in size due to elimination of a separate battery pack. The transmitter fits into a pocket in the clothing or into a case attached to a harness on an animal.

(3) The receiver³ uses 12 tubes, not including the power supply, and is designed to deliver direct current at a voltage proportional to the frequency of the signal. Even though the distance of the transmitter from the antenna varies as the subject moves about, thus changing the received signal strength, the output is not affected,

² Patent applied for; no restrictions on scientific, medical, or educational use.

³ Built by Inductograph Laboratory, Box 76, Brookfield, Connecticut.

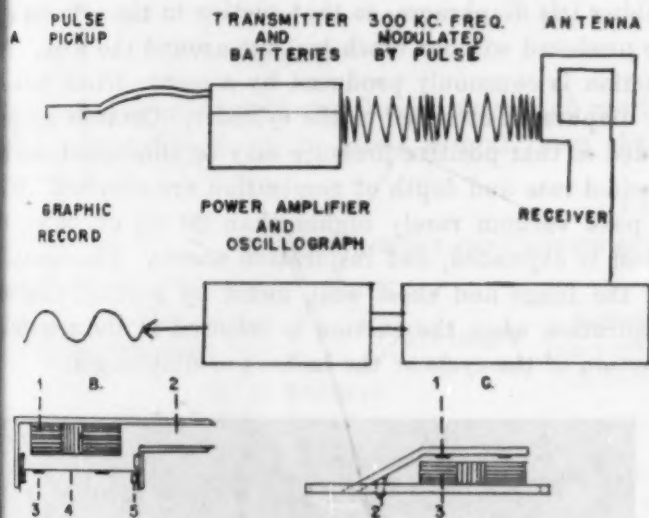


FIG. 1. (A) Schematic diagram of Radio Inductograph system. (B) Cross section of inductor-tambour: 1, coil; 2, air inlet; 3, modulating ring; 4, rubber diaphragm; 5, split ring to hold diaphragm in place. (C) Direct pulse pickup: 1, modulating ring; 2, button placed on artery; 3, coil.

well known that human subjects may respond emotionally to procedures such as the application of a blood pressure cuff, resulting in increased blood pressure. The same is true of animals, as Allen (1) has shown for blood pressure. Fuller (2) has shown that the heart rate and respiration rate of dogs may vary greatly, depending upon the absence or presence of the experimenter. In these experiments, the animals were restrained by loops around the legs. It is certain that some animals are poorly adjusted to this restraint, and even those showing little overt signs of excitement cannot be said to be uninfluenced by the limitation of their activity. The Radio

¹ Assisted by a grant from the John and Mary R. Markle Foundation.

provided the signal is strong enough to be detected. Provision is made for tuning so that other transmitters on adjacent wave bands may be received successively. Visual and auditory monitoring are provided by an electric eye and a phone jack supplied by a special A.F. amplifier.

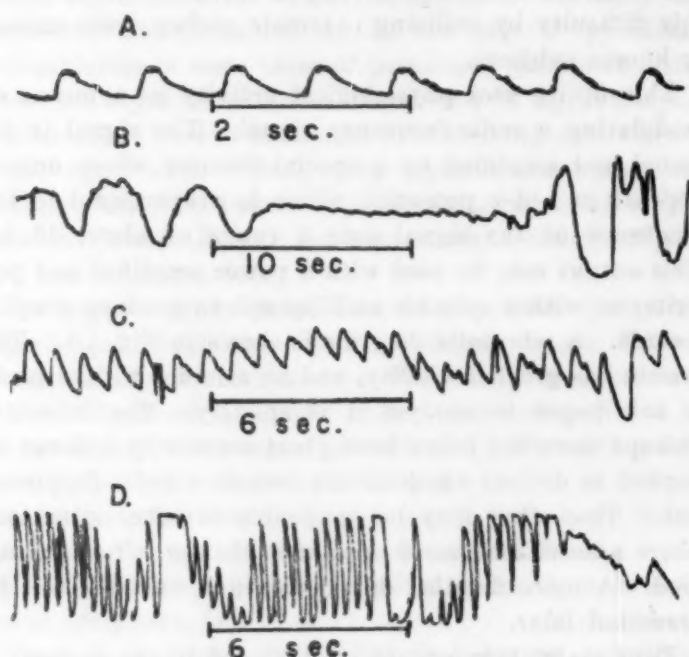


FIG. 2. Sample records made with Radio Inductograph: 1, human carotid pulse; 2, human pneumogram (note that heart rate can be read during period of apnea); 3, human finger pulse; 4, dog pneumogram.

(4) As a recorder we have used a Grass Model III electroencephalograph in which a special low-speed paper-moving mechanism has been installed. The output of the receiver is plugged into the input board of the electroencephalograph, taking care that a common ground connection is made. Because of the relatively high input voltage, the preamplifier of the electroencephalograph is not used, and the receiver output is applied directly to the power amplifier. Sample records made with this arrangement are reproduced in Fig. 2.

The performance of the Radio Inductograph has not been completely determined. Using an antenna zigzagged across an open field approximately 100' x 25', it has been possible to obtain satisfactory records of respiration over the entire area. Some difficulty has been experienced with interference from radio direction beacons operating in the same frequency range. A simple loop antenna hung from the wall will pick up satisfactorily from any part of an average-sized laboratory room. Care has been taken in designing the device to keep the power output within the limitations of the Federal Communications Commission's regulations.

Two types of artifacts may be troublesome. Microphonics may be produced by excessive jarring, but records can be satisfactorily made during moderate activity. Capacitance effects may change the frequency as the subject approaches a large object or turns so as to block the transmitter from the antenna. These difficulties will be corrected in later models.

When adapted to animal or human subjects, the device is inconspicuous and is not uncomfortable when worn for

considerable periods of time. Thus, it may be used to indicate physiological changes with the subject practically unaware that his responses are being recorded. It can also be used in situations when the restraint of the subject would defeat the purpose of the experiment.

References

1. ALLEN, F. M. *J. metab. Res.*, 1922, 4, 131.
2. FULLER, J. L. *J. comp. physiol. Psychol.*, in press.

Design of a Collapsible, Lightweight "Iron Lung" Respirator¹

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When the muscles providing respiration are paralyzed, as in poliomyelitis or high section of the spinal cord, life can be sustained by subjecting the patient to rhythmic negative pressure over all the body excepting the head. The recumbent patient is placed in an iron cylinder (the "iron lung") with the head and neck protruding through an adjustable airtight seal, such as sponge rubber or a rubber iris diaphragm, so that suction in the cylinder can be produced without much leakage around the neck. The suction is commonly produced by a motor-driven bellows or diaphragm attached to the cylinder. Controls are provided so that positive pressure may be eliminated and the desired rate and depth of respiration are obtained. With a peak vacuum rarely higher than 20 cm of water, the chest is expanded, and inspiration occurs. The elasticity of the lungs and chest wall, aided by gravity, produces expiration when the suction is released in the remaining portion of the cycle of the bellows or diaphragm.



FIG. 1

The "iron lung" has disadvantages under particular circumstances. It is heavy and rigid so that it is difficult to transport, occupies considerable storage space, and is expensive. A rubber bellows modification of the "iron lung" is being developed.

¹ Aided by a grant from the Fluid Research Fund of the Yale University School of Medicine.

² Dazian and Kresge Fellow.

... (Iron Lung Company of America) offers improved stability, since it can be transported by ambulance, while the steel cylinder requires a truck. We have found that it is possible to design a cylinder which will be sufficiently rigid to serve as a respirator, and yet which will be composed of lightweight rubberized cloth or pliable plastic sheeting so that it can easily be folded compactly into a suitcase for storage or transportation. A model of Neoprene-impregnated Nylon, which has been tested satisfactorily on an anesthetized cat paralyzed to arrest respiration, is illustrated in Fig. 1.³

differing in that they are interconnected by radial partitions which extend the length of the cylinder. These partitions are not attached to the airtight material at the ends of the cylinder so that air flows freely throughout the double-walled annular enclosure from a single inlet. In the model seen in Fig. 1, a plywood disc carrying a sponge-rubber neckpiece sealed one end of the inner cylinder and also included tubes to permit evacuating the chamber and to measure pressure. The design dimensions and other characteristics of the model constructed are shown in Table 1, the symbols corresponding to those in Fig. 2. An analysis of the forces involved permits one to choose workable dimensions, since not all choices will support an inner evacuated cylinder. In order to equalize the tensions in the outer and inner cylinder sheaths when they are maximal, the angles formed with the line of the partition by the inner and outer sheaths were chosen equal at zero inner cylinder pressure for the projected design of the human respirator, as outlined in Table 1. The tensile strength of the coated fabric used in the model is given as 150 lbs/in in either direction, so that the peak stress of 23 lbs/in to be reached in the partitions in the larger design is not excessive. The mathematical analysis has not allowed for the deformation of the pneumatic cylinder by the weight of the mattress and patient. However, the air pressure of 6 lbs/in² is quite able to sustain such a load with little deformation; actually, the resulting change in shape would probably reduce the over-all bulk.

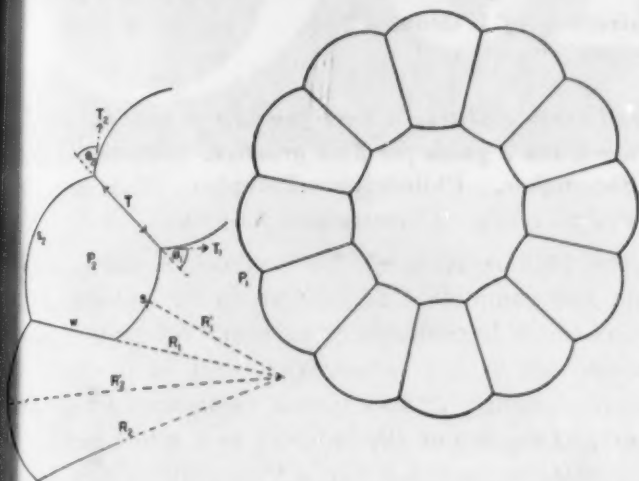


FIG. 2

A spirometer indicated that any desired degree of ventilation can be attained, up to levels several times that

TABLE 1
DIMENSIONS AND CHARACTERISTICS OF COLLAPSIBLE RESPIRATOR

Type	Pressure inside		No. of Width of part- partition tions in inches		Arc length in inches		Radius of inner cylinder in inches		Radius of outer cylinder in inches		Angle in degrees between radius and arcs		Tension in cloth in lbs/in		
	respi- rator wall in in cm of H ₂ O (P ₁)	lbs/in ² (P ₂)	(n)	(w)	inner (S ₁)	outer (S ₂)	mini- mum (R' ₁)	maxi- mum (R ₁)	mini- mum (R' ₂)	maxi- mum (R ₂)	inner cyl- inder (θ ₁)	outer cyl- inder (θ ₂)	inner cyl- inder (T ₁)	outer cyl- inder (T ₂)	parti- tion T
Model for cat	0	2.0	12	3.0	1.5	4.0	2.6	2.8	5.8	6.8	57.9	33.0	5.0	3.2	5.3
Design for human	0	6.0	24	3.0	3.7	5.0	12.2	13.0	16.0	17.1	38.2	38.2	14.6	14.6	23.0
	-20	6.0	24	3.0	3.7	5.0	11.6	12.5	15.5	16.6	31.7	34.5	13.3	13.7	22.6

maintaining in the control period with voluntary respiration. In fact, the 32"-long cylinder, which weighed less than 2 lbs, was easily able to withstand a vacuum of 55 mm of water.

Fig. 2 shows cross sections of a respirator cylinder. It consists of two impervious walls, like a thermos flask, but

We are indebted to David Clark & Company for the Neoprene-coated cloth, to Seamless Rubber Company for dipping in latex, and to Helen Lebensky for sewing the model. A model of vinyl plastic sheeting, made on the electronic sewing machine, was not technically satisfactory but has considerable promise because of the possibility of obtaining a transparent respirator.

The mode of evacuating the air-supported chamber to induce rhythmic respiration need not be different from the methods now in use: bellows; diaphragm; vacuum pump and flexible hose. If desired, a diaphragm can be driven by air pressure alone; in fact, the diaphragm can be two-walled impervious cloth rendered rigid by the same pneumatic principles utilized to support the evacuated chamber. However, since the hollow pressurized wall can be made quite gastight, no constant source of air pressure is required. A tire pump or a cylinder of compressed gas are adequate, inexpensive, freely available, and interchangeable.

Book Reviews

Duftgelenkte Bienen im Dienste der Landwirtschaft und Imkerei (The training of bees for the benefit of agriculture and beekeeping). Karl von Frisch. Vienna: Springer Verlag, 1947. Pp. 189. (Illustrated.) \$3.70 plus postage.

Those who have admired the clear-cut experiments of von Frisch will welcome this recent handbook. A delightfully readable style permeates this volume, as it did such classics of sensory physiology as *Die Sprache der Bienen*, . . . *Gehörsinn der Fische*, *Über einen Schreckstoff der Fischhaut* . . . , etc. Written in short sentences and short paragraphs, the book could well serve beekeepers, at whom it is aimed, even if they possess only a fair reading ability in German. Also, the sensory physiologist will find it helpful, since many of the original papers from which most of this work was drawn may not be available.

This handbook deals with a new technique of "training" or "conditioning" honeybees to work an appropriate plant at a desired time in order to increase seed production and, in some instances, to increase honey yields.

Described also are experiments which show that bees are able not only to communicate the odor of a food source (e.g. clover), but also to inform their colleagues, through characteristic "dances" on the comb, of the distance of the food source from the hive. In addition, the author gives evidence that they also communicate the approximate direction in which the food source lies.

The techniques used for "training" bees to certain flowers for which greater visitation is desired are described in detail. Essentially, the bees are fed on odorless sugar syrup surrounded with the fresh blossoms (or their extract) so that, returning to the hive with the sugar syrup, they will convey the odor of the blossoms to the other bees in the hive, which in turn will then search for those flowers as a source of nectar. The syrup can be sprinkled over bouquets of the blossoms, or the blossoms may be offered as a fresh reminder each day in a pan of syrup placed at the hive entrance. The high visitation rate thus attained results in increased seed production.

Also included are data on the experiments of training bees to various wild and cultivated plants, descriptions and pictures of the species concerned, exhaustive data on the practical application of the "training" principles, and records of seed and honey production of the various research units.

This book should be highly recommended to those people making pollination studies, and the work should be repeated, modified, and tried in many localities in this country to find where it can most profitably be used; Russian and English workers have had success with these techniques.

In conclusion, liberally translated, von Frisch states: "Doubtless increased seed and honey yields can be attained by the bee-training techniques described. How-

ever, to put these methods into practice the written word hardly suffices. I strongly recommend that agricultural experiment stations inaugurate demonstrations which can be viewed or, better, where beekeepers can actually attend a short course and participate while learning the techniques."

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Small-fruit culture: a text for instruction and reference work and a guide for field practice. (2nd ed.) James H. Shoemaker. Philadelphia-Toronto: Blakiston, 1948. Pp. vii + 433. (Illustrated.) \$4.00.

The 1948 revision of this textbook is the most up-to-date and complete text relative to the culture of the fruits which is available at present. Although it does not include all of the information that is pertinent to any specific locality, it does give a well-rounded view of the practical aspects of the industry as a whole and, as such, is a valuable textbook for a "general" course in small fruits. However, like most horticultural texts, it must be supplemented with bulletins, circulars, technical papers, etc. to acquaint the student with additional information relative to the area in which the course is being taught.

A complete bibliography of 536 references, listed alphabetically according to author, is given in the rear of the text. This further increases the value of the book as a text as students can readily acquaint themselves with the experimental work which has been done in all sections of the United States and parts of Canada.

The very attractive cover is rather unique in that it is a full-cover reproduction of a fruiting strawberry plant. The illustrations in the text, which now number 64, may well be increased to include the latest developments in the equipment, machinery, and packaging fields in order to better acquaint the students with this phase of the industry.

The crops discussed in the text are grapes, strawberries, brambles, currants, gooseberries, blueberries, and raspberries, three-fourths of the book being devoted to the first three fruits listed. In the case of each fruit, the important producing regions are discussed, thus giving a picture of the extent of the industry, and this is followed by fundamental information pertinent to the culture of the fruit. Throughout the text, stress is placed on fundamental information, thus making it possible to develop a discussion which will bring out specific details that are pertinent to any one region. Much of the information given in the text is substantiated by experimental data from the various Experiment Stations.

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